Highway Safety Literature

An Announcement of Recent Acquisitions. . .

71-25

HSL No. 25 September 24, 1971 HS-009 756 - 819, HS-600 519, HS-800 486 - 490, HS-800 500 - 503, HS-800 508

HSL No. 71-25
September 24, 1971

SPECIAL NOTICE
Page 29

THIS ISSUE CONTAINS:

HS-009 756 - HS-009 819
HS-600 519
HS-800 486 - HS-800 490
HS-800 500 - HS-800 503
HS-800 508

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HIGHWAY SAFETY LITERATURE
AN ANNOUNCEMENT OF RECENT ACQUISITIONS

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INTRODUCTION

Publications announced in *Highway Safety Literature* include the most recent additions to the collection of the NHTSA Scientific & Technical Information Service. Subject areas covered include all phases of highway, motor vehicle, and traffic safety, especially those encompassed by the National Traffic and Motor Vehicle Safety Act of 1966 and the Highway Safety Act of 1966.

Individual issues of *HSL* are numbered according to the year and the issue number within that year; thus, 71 designates the year and 1, 2, 3, etc. the individual issues To aid the user in location citations by the HS-number. the cover bears the inclusive entry numbers for each issue.

Entries in *HSL* are arranged according to the revised NHTSA Subject Catagory List shown in the Table of Contents. The List is a two-level arrangement consisting of five major subject fields subdivided into 59 subject groups. Documents related directly to the National Highway Traffic Safety Administration (NHTSA) are announced in a separate section headed NHTSA DOCUMENTS and are numbered in five distinct series: NHTSA Accident Investigation Reports (HS-600 000 series). NHTSA Compliance Test Reports (HS-610 000 series), NHTSA Contractors Reports (HS-800 000 series), NHTSA Staff Speeches, Papers, etc. (HS-810 000 series), and NHTSA Imprints (HS-820 000 series). For NHTSA DOCUMENTS in series HS-600 000 and HS-610 000, individual full case reports are available for inspection at the National Highway Traffic Safety Administration. HS-800 000 series and HS-820 000 series are available for sale/or purchase from NTIS or GPO (see page ii). Although announced together in a separate section, these documents are also assigned specific subject categories for machine retrieval

A document which contains a number of separate articles is announced as a complete volume in the subject category most applicable to it as a whole. Entries for the individual articles appear in their most specific subject category.

SAMPLE ENTRIES

Subject Category Array

NHSB Accession no..... HS-800 218 Fld. 5/21; 5/9

Title of document..... AN INVESTIGATION OF USED CAR SAFETY STANDARDS--SAFETY INDEX: FINAL REPORT. VOL. 6 - APPENDICES G-L

Personal author(s)..... by E. N. Wells; J. P. Fitzmaurice; C. E. Guilliams; S. R. Kalin; P. D. Williams

Corporate author..... Operations Research, Inc.

Collation

Publication date..... 12 Sep 1969 150p
Contract FH-11-6921
Report no. ORI-TR-553-Vol-6; PB-190 523

Abstract..... Appendices G-L to this study of used car safety standards include: indenture model diagrams for classes I-IV motor trucks; degradation, wear, and failure data for motor truck classes I-IV; and safety index tables for classes I-IV motor trucks.

Search terms; Wear; Trucks Failures; Used cars; Inspection standards

AVAILABILITY: NTIS

HS-004 497 Fld. 5/19

AUTO THEFT–THE PROBLEM AND THE CHALLENGE

by Thomas A. Williams, Sr.

Journal citation . . . Published in *FBI Law Enforcement Bulletin* v37 n12 p15-7 (Dec 1968)

Gives figures on the extent of the auto theft problem and comments on antitheft devices available now or in the planning stage.

Search terms: Theft; Theft protection; Stolen cars

TABLE OF CONTENTS

NOTE: ( ) Numbers in parentheses following certain subject groups indicate the Highway Safety Program Standards (No. 1, and up) and/or Federal Motor Vehicle Safety Standards (No. 101 and up) which may apply to these groups.

INTRODUCTION AND SAMPLE ENTRIES . . . . . Inside Front Cover
AVAILABILITY OF DOCUMENTS ii

NHTSA SUBJECT FIELDS AND GROUPS

1/0 ACCIDENTS 1
- /1 Emergency Services (11, 15-16)
- /2 Injuries
- /3 Investigation (10, 14-15)
- /4 Locations (9, 14)
- /5 Statistical data

2/0 HIGHWAY SAFETY 3
- /1 Breakaway Structures
- /2 Communications
- /3 Debris Hazard Control and Cleanup (15-16)
- /4 Design and Construction (12, 14)
- /5 Lighting (14)
- /6 Maintenance (12)
- /7 Meteorological Conditions
- /8 Police Traffic Services (15)
- /9 Traffic Control (13-14)
- /10 Traffic Courts (7)
- /11 Traffic Records (10)

3/0 HUMAN FACTORS 5
- /1 Alcohol (8, 14)
- /2 Anthropomorphic Data
- /3 Cyclists
- /4 Driver Behavior
- /5 Driver Education (4, 14)
- /6 Driver Licensing (5, 10, 14)
- /7 Drugs Other Than Alcohol
- /8 Environmental Effects
- /9 Impaired Drivers
- /10 Passengers
- /11 Pedestrians (14-15)
- /12 Vision

4/0 OTHER SAFETY-RELATED AREAS 8
- /1 Codes and Laws (6)
- /2 Community Support (17)
- /3 Cost Effectiveness
- /4 Governmental Aspects
- /5 Information Technology
- /6 Insurance
- /7 Mathematical Sciences
- /8 Transportation Systems

5/0 VEHICLE SAFETY 8

* All Federal Motor Vehicle Safety Standards apply to passenger vehicles. An asterisk before a subject group indicates additional types of vehicles to which the indicated standards may apply.

- /1 Brake Systems (102, 105-6, 116)
- */2 Buses, School Buses, and Multipurpose Passenger Vehicles (102-4 , 106-8, 111-3, 116, 205-6, 209, 211)
- */3 Cycles (3; 108, 112, 116, 205)
- /4 Design (14; 101-2, 105, 107, 201)
- /5 Door Systems (201, 206)
- /6 Fuel Systems (101, 301)
- /7 Glazing Materials (205)
- /8 Hood Latch Systems (113)
- /9 Inspection (1)
- /10 Lighting Systems (101, 105, 108, 112)
- /11 Maintenance and Repairs
- /12 Manufacturers, Distributors, and Dealers
- /13 Mirrors and Mountings (107, 111)
- /14 Occupant Protection (15; 201-4, 207-10)
- /15 Propulsion Systems
- /16 Registration (2, 10)
- /17 Safety Defect Control
- /18 Steering Control System (101, 107, 203-4)
- /19 Theft Protection (114-5)
- */20 Trucks and Trailers (102-4, 107-8, 112-3, 116, 205-6, 209)
- /21 Used Vehicles
- /22 Wheel Systems (109-10, 211)
- /23 Windshield-Related Systems (101, 103-4, 107, 205, 212)

NHTSA DOCUMENTS 17
EXECUTIVE SUMMARIES 21

NOTE: Material published in Highway Safety Literature (HSL) is intended for the information and assistance of the motor vehicle and highway safety community While brands names, equipment model names and identification, and companies may be mentioned from time to time, this data is included as an information service. Inclusion of this information in the HSL should not, under any circumstances, be construed as an endorsement or an approval by the U. S. Department of Transportation, National Highway Traffic Safety Administration of any particular product, course, or equipment.

Harry A. Feinberg
Managing Editor

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AND
INSTRUCTIONS FOR ORDERING

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HRB: Highway Research Board, National Academy of Sciences, 2101 Constitution Ave., N. W., Washington, D. C. 20418.

NHTSA: National Highway Traffic Safety Administration General Services Division, Washington, D.C. 20591 (Telephone (202) 426-0874),

SAE: Society of Automotive Engineers, Dept. HSL, 2 Pennsylvania Plaza, New York, N.Y. 10001. Order by SAE report numbers. Prices given are list; discounts are available to members and sometimes to libraries and U. S. Government Agencies. Prepayment is required; orders without payment are subject to a $1 handling charge.

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1/0 ACCIDENTS

1/1 Emergency Services

HS-009 756 Fld. 1/1

TRANSPORTATION OF THE ACUTELY INJURED – A NEGLECTED "DISEASE" WITH A "CURE"

by J. T. Littleton

Published in *Police* v9 n2 p16-21 (Nov-Dec 1964)

Transportation of the acutely injured is not always handled properly, whether at the scene of the accident or within the hospital. A survey showed that the average number of acutely injured patient moves was 6.7. A system for patient transport is described. It consists of a removable stretcher top which reduces the number of painful moves for acutely injured patients to two, from the street to the stretcher-top and from the stretcher top to the ultimate hospital bed. A technique is also described whereby this system can be adapted to provide facilities for transporting and housing multiple acutely injured patients from mass casualty accidents. This system has been used only in a rural community, but theoretically it could lend itself to municipalities as well.

Search terms: Transportation of injured; Ambulances; Stretchers; Hospital emergency rooms; Emergency medical services; Injury severity

HS-009 757 Fld. 1/1

AMBULANCE SERVICE AND TRAFFIC CASUALITIES. REPORT OF THE CORNWALL AREA TRAFFIC CASUALTY STUDY, DECEMBER 1st, 1959 TO NOVEMBER 30th, 1960,

by L. A. Caldwell

Published in *Ontario Medical Review* p172-82, 233-4 (Mar 1961)

27 refs

The present status of emergency ambulance services in Ontario is reviewed. Allegations of inadequate returns for emergency ambulance services on the highway are substantiated. There is a complete lack of provincial regulations governing the licensing, equipment, and staffing of ambulances. The same lack applies to first aid certification of ambulance personnel and regular inspection of ambulances. Recommendations for improvement are given.

Search terms: Ambulances; Transportation of injured; Ambulance personnel training; Ambulance licensing; Emergency equipment; First aid; Economic factors; Emergency medical services; Time factors; Vehicle operating costs; Ontario

1/3 Investigation

HS-009 758 Fld. 1/3

HOW TO ACHIEVE UNIFORM STATISTICS ON TRAFFIC ACCIDENTS

by Aage la Cour

Economic Commission for Europe

29 Jun 1970 13p
Report no. WP6/265; WP20/197; GE.70-13571

Inconsistencies in manner of reporting traffic accidents makes it difficult to achieve uniform primary statistics on such accidents. A system used in Denmark since 1967 is described. The system includes all accidents involving personal injury where a police report is made. The first part of the report is filled out by the policeman. The second part is a questionnaire completed in the police district by specially-trained policemen in charge of the analysis and detailed treatment of the traffic accidents. These data are then transferred to punched cards and processed statistically.

Search terms: Traffic accidents; Accident report forms; Injury statistics; Accident reports; Accident statistics; Denmark; Police reports

AVAILABILITY: A reference copy only is in NHTSA Technical Reference Div.; no copies available for distribution

HS-009 759 Fld. 1/3

THE NATURE OF THE COLLISION. A STUDY OF BRITISH ROAD ACCIDENTS

by G. M. Mackay

Published in *Technical Aspects of Rc Safety* n42-43 p2.1-2.13 (Mar 1970)

5 refs

Some data from a representative sample of British cars involved in urban and rural collisions are given. The information was obtained from statistically representative sample studies of accidents visited at the scene within some 30 minutes of their occurrence. The relative frequency of various crash configurations is given and some of the consequences in terms of rollover experience, door opening rates, and penetration of the passenger compartment are discussed. The reduction in door opening rates with the use of anti-burst latch designs is illustrated. Variations in collision speeds with environmental changes are outlined. These results provide some insight into the priorities of crash protective design, in terms of establishing the relative importance of various crash configurations.

Search terms: Accident studies; Crashworthiness; Automobile design; Body failures; Impact protection; Roof failures; Occupant protection; Great Britain; Rollover accidents; Crashworthy bodies; Passenger compartments; Door latches; Door system failures; Impact forces; Impact velocity; Crushing

HS-009 760 Fld. 1/3; 2/7

REDUCTION OF WET PAVEMENT ACCIDENTS ON LOS ANGELES METROPOLITAN FREEWAYS

by Eugene E. Farnsworth; Melvin H. Johnson

California Div. of Highways

1971 17p 2 refs
Report no. SAE-710574

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

Improved pavement surface construction methods for new pavements and the use of pavement grooving and thin blankets for existing pavements are solutions to the wet pavement accident problem. Before and after accident studies of pavement grooving projects indicate a reduction of 85% of the wet pavement accidents.

Search terms: Pavement surface texture; Wet road conditions; Grooving; Pavement skid resistance; Concrete pavements; Asphalt pavements; Skid resistance tests; Los Angeles; Pavement wear; Accident studies

AVAILABILITY: SAE

HS-009 761 Fld. 1/3; 2/9

UBER DEN ZUSAMMENHANG ZWISCHEN VERKEHRUNFALLEN UND VERKEHRSBELASTUNG AUF EINEM DEUTSCHEN AUTOBAHNABSCHNITT (ON THE CONNECTION BETWEEN TRAFFIC ACCIDENTS AND TRAFFIC VOLUME ON A SECTION OF A GERMAN AUTOBAHN)

by W. Leutzbach; W. Siegener; R. Wiedemann

Published in *Accident Analysis and Prevention* v2 p93-102 (1970)

8 refs

Text in German.

The object of this research was to investigate the dependence of the number and type of accidents on traffic volume for a section of autobahn in the Federal Republic of Germany. Particular emphasis was placed on rear end collisions which on German motorways constitute a large percentage of all accidents. An attempt was made to find an explanation for this in terms of the interrelationship between headway and traffic volume.

Search terms: Traffic volume; Accident research; Accident studies; Rear end collisions; West Germany; Headways; Mathematical models; Accident rates

1/5 Statistical Data

HS-009 762 Fld. 1/5

COMPARISON OF THE SAFETY RECORDS OF BRITISH RAILWAYS AND THE HIGHWAYS OF BRITAIN

by T. I. Lloyd

Published in *Accident Analysis and Prevention* v2 p111-25 (1970)

This study covers a one-year period 1966/67 and lists the officially reported British Railways and highway casualties for the year; these official casualty lists are then reviewed and revised to yield statistically comparable rail and road casualty totals for the year. To determine the number of persons at risk or each system the study uses BR statistics from which to arrive at the daily average number of person-hours exposed to risk on the BR system throughout the year, and there follows a similar calculation arriving at the daily average number of person-hours spent exposed to risk on the highway system throughout the year; for the purposes of this latter calculation official highway statistics existed, except in respect of pedestrianism, the volume of which is deduced. The final comparison shows that, broadly, persons on British Railways are twice as likely to suffer fatal or serious injury as persons on the highway system, and five times as likely to suffer moderate injury.

Search terms: Fatalities; Accident statistics; Railroad accidents; Injury statistics; Injury classification; Fatality rates; Injury rates; Great Britain; Accident rates; Accident risks; Pedestrian accidents

HS-009 763 Fld. 1/5; 1/3

AGE AND SEX OF DRIVERS INVOLVED IN FATAL CRASHES IN MICHIGAN DURING 1968

by Thomas L. McDole

Published in *HIT Lab Reports* p10-2. (Feb 1971)

2 refs

Three thousand fifty-seven vehicle operators were involved in 2,015 fatal crashes in Michigan in 1968. A distribution of the number of crashes for each age level of operator involved was studied. It was found that male operators were involved in five times as many fatal crashes as female operators, and that operators between ages 15 and 31 accounted for 50% of all fatal crash involvements. The peak fatal crash involvement occurred at ages 18-22 for males and at age 18 for females. The male and female crash distributions (number of crashes for each age level of operator involved) were normalized, and when compared they were found to be identical. Thus, the patterns of involvement by age for males and females are the same, only the number of involvements are different. Several additional topics for future investigation are also given.

Search terms: Accident studies; Fatality rates; Accident analysis; Age

factor in accidents; Sex factors in accidents; Female drivers; Male drivers; Fatalities by age; Fatalities by sex; Accident rates; Young adult drivers; Adolescent drivers; Michigan

HS-009 764 Fld. 1/5; 5/2

1968 ACCIDENTS OF CLASS 1 MOTOR CARRIERS OF PASSENGERS

Bureau of Motor Carrier Safety

Dec 1969 6p

This report is a nation-wide summary of accidents involving Class 1 interstate motor carriers of passengers for 1968. (Class 1 motor carriers are defined as those having annual operating revenues of $200,000 or more.) The accidents cited resulted in fatalities, injuries, or property damage of $250 or more. Two hundred sixty-three carriers reported 1,828 accidents, resulting in 121 fatalities, 3,465 injuries, and $3,107,040 property damage. The accident frequency rate per million vehicle miles was 1.50. The fatality rate per 100 million vehicle miles was 9.93. The data presented are deemed adequate to identify accident trends and problem areas peculiar to interstate operations. Data are tabulated for 1964-68.

Search terms: Accident statistics; Passenger fatalities; Driver fatalities; Accident rates; Bus accidents; Accident types; Fatality rates; Injury rates

HS-009 765 Fld. 1/5; 5/20

1968 ACCIDENTS OF LARGE MOTOR CARRIERS OF PROPERTY

Bureau of Motor Carrier Safety

Dec 1969 10p

This report is a nation-wide summary of accidents involving large motor carriers of property for 1968. (Large motor carriers are defined as those having annual operating revenues of $300,000 or more.) The accidents cited resulted in fatalities, injuries, or property damage of $250 or more. Two thousand seven hundred thirty-four carriers reported 29,209 intercity accidents, resulting in 1,421 fatalities, 16,124 injuries, and $66,871,490 property damage. The accident frequency rate per million vehicle miles was 2.50. The accident fatality rate per 100 million vehicle miles was 12.14. The data reported are deemed adequate to identify accident trends and problem areas peculiar to interstate operations.

Search terms: Truck accidents; Accident statistics; Fatalities; Accident rates; Accident types; Fatality rates; Day of week; Time of accidents; Driver age; Injury rates

2/0 HIGHWAY SAFETY

HS-009 766 Fld. 2/0; 4/3

DESIGN OF AN INTEGRATED TRAFFIC SAFETY SYSTEM FOR PUERTO RICO

by Appu Kuttan

1970 14p 2 refs

Presented at the 6th World Highway Conference, Montreal, 4-10 Oct 1970.

The design of an integrated traffic safety system for Puerto Rico is described. The design strategy employed is the ESD (Effective System Design) technique. A two-dimensional analysis of the entire traffic safety system resulted in the identification of 24 subsystems. An interdisciplinary team approach was used to study the subsystems and establish cost effectiveness for each of the system measures. For each measure the research team will establish priority, formulate the measure, and prepare an implementation plan.

Search terms: Highway safety programs; Systems analysis; Benefit cost analysis; Priorities; Interdisciplinary teams; Puerto Rico

2/3 Debris Hazard Control and Cleanup

HS-009 767 Fld. 2/3; 1/3; 2/9

RESTORING FREEWAY OPERATION AFTER TRAFFIC ACCIDENTS

by Frank L. Lynch; Charles J. Keese

Texas A & M Univ. Texas Transp. Inst.

1964 21p 7 refs
Report no. Bull-28

The effects of traffic accidents on freeway operation were studied. A research project was established to determine areas where possible improvements could be made in reducing the time lost to freeway users due to an accident occurring on the freeway and restricting the flow. Another phase of the project included the determination of the drivers reaction to the situation, once involved in an accident. This report was designed to encourage awareness on the part of the police department, the investigation officers, and the freeway drivers of the problems encountered by each after an accident, and to indicate problem areas that may be improved by departmental operation changes, individual improvements, and increased education of the freeway drivers.

Search terms: Debris removal; Emergency vehicles; Wreckers; Accident location; Traffic flow; Freeways; Police response time; Traffic congestion; Emergency reporting systems; Roadside telephones; Time factors; Accident investigation

2/4 Design and Construction

HS-009 768 Fld. 2/4

SKIDDING ON WET PAVEMENTS: THE DRAINAGE CHARACTERTICS OF VARIOUS SURFACES

by K. B. Wallace; D. H. Trollope

2/4 Design and Construction (Cont'd.)

HS-009 768 (Cont'd.)

Published in *Australian Road Research Board Proceedings* 1964 v2 pt1 p463-77

6 refs
Report no. Paper-162

Presented at the third conference, Sydney.

Unless there are adequate drainage paths through which water may escape from beneath a tire skidding on a wet pavement, skidding resistance is drastically lowered. This paper describes a series of experiments which measure the pressure gradient and discharge for flow between a smooth plate and idealized pavement surfaces. From preliminary tests it appears that the drainage characteristics for various surfaces can be related by a simple function of the texture depth. For small projection heights the drainage characteristics are very sensitive to small changes of texture depth, which may not be detected by present field measuring techniques. The results also illustrate the effect of variation of tread depth on surfaces of varying projection size and show that projection size will have very little effect on a tire hydroplaning on a thick layer of water.

Search terms: Hydroplaning; Wet skidding; Drainage; Pavement skid resistance; Pressure responses; Pavement skidding characteristics; Mathematical models; Tire road conditions; Tire tread depths

HS-009 769 Fld. 2/4

A STUDY OF ROAD FRICTION IN NEW SOUTH WALES

by N. W. West; T. F. Ross

Published in *Australian Road Research Board Proceedings* 1964 v2 pt1 p478-95

28 refs
Report no. Paper-185

Presented at the third conference, Sydney.

Experimental work in connection with several factors contributing to road friction is reported. The information is required to assist in the interpretation of the accelerated polishing test values of aggregate, herein described, in relation to traffic and road conditions; and also to the type of bituminous surface in which the aggregate is used. The difficulty of evaluating an aggregate from the point of veiw of polishing characteristics for a particular purpose is discussed and a method of dealing with the problem is suggested. The experiments described include correlation tests between field and laboratory polishing, the effect of aggregate size on the measurement of coefficient of friction by a pendulum device, and the effect of the polishing process of aggregate of dry and wet abrading grit, etc., and a successful method of using aggregate susceptible to polishing in dense-graded bituminous hot mix. Further attention has been given to treatment of wooden and steel bridge decking to increase their skid resistance.

Search terms: Friction studies; Polishing; Aggregates; Bituminous concrete pavements; Bridge surfaces; Pavement skid resistance; Pavement friction; Coefficient of friction; Pavement skidding characteristics; Pavement wear; Laboratory tests; Road tests

HS-009 770 Fld. 2/4

THE USE OF NATURAL RUBBER IN ROAD SURFACINGS

by P. D. Thompson

Natural Rubber Producer's Res. Assoc. (England)

1964 31p
Report no. TB-9

Natural Rubber in Road Surfaces. This bulletin is designed to be complementary to Road Note no. 36, *Specification for the Manufacture and Use of Rubberised Bituminous Road Materials and Binders.*

For a number of years, the Road Research Lab. in cooperation with the Natural Rubber Producer's Research Association, has carried out research on rubberized road materials. Aspects of this research presented here are: the rubber additive; the physical and mechanical properties of rubber-bitumen; preparation of rubberized bitumen; rubber in surface-dressing; rubberized tar; rubber in mastic asphalt; rubber in bituminous pre-mix surfacings; rubber in bituminous emulsion; rubber for bridge surfacings; storage of rubberized bitumen; and cost.

Search terms: Rubber; Rubber compounds; Elastomer modified asphalts; Bituminous materials; Bituminous concrete pavements; Pavement surface texture; Pavement strength; Bridge surfaces; Physical properties; Mehhanical properties; Rubber compounding; Emulsions; Rubber storage; Costs

2/9 Traffic Control

HS-009 771 Fld. 2/9

TESTS TO DETERMINE THE DESIGN OF ROADSIDE SOFT ARRESTER BEDS

by I. B. Laker

England Road Research Lab.

1971 24p 3 refs
Report no. RRL-LR-376

Full-scale tests have shown that soft arrester beds should be suitable for stopping vehicles which lose their brakes on long down-gradients. The deceleration of private cars and heavy vehicles was measured after end-on entry at high speeds into a long bed of lightweight aggregate material (Lytag). Two other beds of Lytag were used to study side-entry into arrester beds of differing widths, one wide enough to accept the

wheels on both sides of a vehicle (dual-track bed) and the other wide enough to accept only the wheels on one side of a vehicle (single-track bed). With end-on entry all the vehicles were stopped satisfactorily from 72 km/h without the use of brakes at deceleration value of 0.5g. In the case of the dual-track bed a 300 mm high curb was required along the far side to ensure that the vehicles were contained within it for typical side-entry angles of 5°-10° to the length of the bed. In the case of the single-track bed a 300 mm high curb surmounted by a hydraulic crash barrier was found to be necessary. This arrangement decelerated vehicles at about 0.3g on level ground corresponding to about 0.2g on a down hill gradient of 1 in 10.

Search terms: Road shoulders; Materials tests; Deceleration lanes; Hydraulic barriers; Aggregates; Road grades; Brake failures; Deceleration tests; Truck escape lanes

HS-009 772 Fld. 2/9

ANALYSIS OF SINGLE LANE TRAFFIC FLOW

by L. D. Edie; R. S. Foote; Robert Herman; Richard Rothery

Published in *Traffic Engineering* v33 n4 p21-7 (Jan 1963)

10 refs

A large sample of speed, concentration, and flow data has been obtained in the Holland Tunnel, New York City. This has been made possible by the use of electronic instrumentation designed for the purpose of traffic analysis. The data concerning a sample of about 24,000 vehicles has been analyzed with respect to speed-concentration and flow-concentration relationships. A preliminary study has been made on platooning of vehicles and a discussion given of traffic noise as a measure of smoothness of traffic flow. Mathematical details of the analysis are given.

Search terms: Traffic data analysis; Traffic density; Traffic volume; Traffic flow; Traffic noise; Platoons; Vehicle detectors; Mathematical analysis; Speed volume relationships; Speed patterns; Tunnel traffic flow; Traffic density

HS-009 773 Fld. 2/9

A RATIONAL METHOD FOR THE CAPACITY ANALYSIS OF A MULTIPLE WEAVING SECTION

by R. S. Purdie

Published in *Australian Road Research Board Proceedings* 1964 n2 pt1 p403-17

2 refs
Report no. Paper-183

Presented at the third conference, Sydney.

An examination is made of the traffic movements which take place within a multiple weaving section and a series-parallel concept is introduced from which a method is developed for a capacity analysis. The established method for analyzing simple weaving sections is used to provide a capacity relationship which is applied to the analysis of a multple weaving section. A simple set of rules is given which enables a capacity analysis to be performed quickly and easily on a multiple weaving section of any degree of complexity. The design chart used for the capacity analysis of simple weaving is the only aid required to make the analysis.

Search terms: Traffic data analysis; Traffic simulation; Traffic research; Highway design; Weaving capacity; Traffic volume; Merging capacity; Traffic flow

HS-009 774 Fld. 2/9

TRAFFIC CENSUS RESULTS FOR 1969

by J. B. Dunn

England Road Research Lab.

1970 26p 18 refs
Report no. RRL-LR-371

This report gives estimates of the volume of traffic in Great Britain in 1969, together with figures for earlier years. The figures are based on manual censuses at over 1,000 points giving levels for 1960 and 1966; estimates for the other years have been obtained by applying trends from regular censuses at 50 points up to 1965 and at about 200 points from 1966. More detailed reults are given of the continuous automatic census at 50 points on trunk, principal and classified roads which has been in progress since January 1956. The increase of motor traffic between 1968 and 1969 was about 3 per cent; this increase was the lowest in recent years. In 1969 travel on motorways represented 4 percent of the travel on all roads.

Search terms: Traffic surveys; Traffic counts; Traffic volume; Highway usage; Traffic estimates; Vehicle usage; Traffic flow; Traffic distribution; Great Britain; Travel patterns; Travel modes

3/0 HUMAN FACTORS

3/1 Alcohol

HS-009 775 Fld. 3/1; 1/2; 1/5

FACTORS ASSOCIATED WITH POLICE EVALUATION OF DRINKING IN FATAL HIGHWAY CRASHES

by Julian A. Waller

Published in *Journal of Safety Research* v3 n1 p35-41 (Mar 1971)

11 refs

3/1 Alcohol (Cont'd.)

HS-009 775 (Cont'd.)

Police estimates of drinking by fatally injured drivers and pedestrians as recorded on police reports of investigations of crashes were compared with actual blood alcohol concentrations of the fatalities determined by the coroner's office. Over 20% of the time alcohol was not mentioned at all in the police report. When alochol was mentioned, its presence was underestimated, especially at concentrations under 200 mg%. Furthermore, alcohol was least likely to be reported among persons age 60 or older, pedestrians, non-responsible fatalities, and drivers of new cars. It was most often reported among younger persons, drivers responsible for two-vehicle crashes, and drivers of old cars.

Search terms: Drinking drivers; Blood alcohol levels; Accident statistics; Drinking pedestrians; Fatality causes; Police reports; Autopsies; Driver intoxication; Pedestrian fatalities; Driver fatalities; Age factor in accidents; Accident responsibility; Vehicle age

HS-009 776 Fld. 3/1; 3/4

THE EFFECTS OF SMALL DOSES OF ALCOHOL ON A SIMULATED DRIVING TASK

by Gary L. Martin

Published in *Journal of Safety Research* v3 n1 p21-7 (Mar 1971)

16 refs

The present study examined the effects of small doses of alcohol on the operator inputs and vehicle responses found in part-task, non-programmed, driving simulation. In an attempt to relate simulated and actual driving, the only operator inputs measured were those with a demonstrable relationship to those inputs found in actual driving. Twelve male subjects were tested under three counterbalanced alcohol dose conditions, no alcohol, and two doses calculated to attain blood alcohol concentrations of .05 and .10 percent accelerator reversals did not discriminate between the three alcohol groups while two steering measures were significant sources of variation. Tracking scores revealed no significant differences for the three alcohol groups, although a statistically significant dose x subjects interaction was found in each case.

Search terms: Blood alcohol levels; Alcohol effects; Driving simulation; Breathalizers; Driver performance; Driver tasks; Drinking drivers; Variance analysis

3/2 Anthropomorphic Data

HS-009 777 Fld. 3/2

BACK STRAINS: THE STATE OF THE ART

by D. F. Jones

Published in *Journal of Safety Research* v3 n1 p28-34 (Mar 1971)

17 refs

The history of manual lifting techniques and resulting stresses in components of the human trunk are reviewed. Papers by Bradford and Spurling (1945) and Bartelink (1957) are utilized to develop a new hypothesis respecting the interacting role of the three mehcanisms of lifting (spine, muscles, intra-abdominal pressure) to stimulate further research in this field.

Search terms: Back injuries; Spine; Back; State of the art studies; Muscles; Stress (physiology); Stress strain characteristics

3/4 Driver Behavior

HS-009 778 Fld. 3/4

PROPAGANDA AND ALTERNATIVE COUNTERMEASURES FOR ROAD SAFETY

by D. J. Griep

Published in *Accident Analysis and Prevention* v2 p127-40 (1970)

24 refs

Knowledge of the psychology of driving behavior is incomplete and does not in fact deserve the name if it is to be limited to conditions existing "inside" the driver. Compared to other opportunities for influencing driving behavior, in particular those involving "external" conditions, present-day road safety propaganda offers little hope of bringing about any appreciable reduction in traffic accidents. It is assumed that safety propaganda can be effective with road-users in increasing their knowledge and appreciation of the conditions that affect driving behavior (and thus road safety). The conditions that have an effect on this behavior are not, however, exclusively under control of the road-user; therefore, if road safety propaganda is to be carried out, it must be not directed solely towards the road-user. Where there is a lack of adequate knowledge as to driving behavior and the conditions that influence it, then propaganda should create opportunities for increasing this knowledge.

Search terms: Driver attitudes; Driver behavior; Safety propaganda; Mass media; Safety campaigns; Driver personality; Driving conditions; Psychological factors; Safety program effectiveness; Driver improvement; Liability; Driver characteristics; Accident causes

HS-009 779 Fld. 3/4

CHARACTERISTICS OF DRIVERS OBTAINED FROM LARGE SCALE ENQUIRIES

by D. Sheppard

England Road Research Lab.

1971 24p 14 refs
Report no. RRL-LR-389

This report presents data from sample surveys dealing with characteristics of drivers. The ways in which these characteristics are distributed among the total population of drivers and among special sub-groups of drivers are shown. Data about drivers' experience, the types of vehicles driven, driving practices, and the frequency of offences and accidents are given together with sociometric data. The difficulties which can arise from carrying out inquiries among less adequate samples of drivers are stressed, but the data presented can also be used for applying correction factors or for weighting when inquiries among less adequate samples of drivers are inevitable.

Search terms: Driver characteristics; Driver age; Driver sex; Driver occupation; Driver experience; Driver mileage; Driving; Traffic law violations; Surveys; Driver social class; Vehicle characteristics; Driver statistics; Socioeconomic data

HS-009 780 Fld. 3/4

A PROGRAM OF RESEARCH IN "HIGHWAY HYPNOSIS": A PRELIMINARY REPORT

by Ronald E. Shor; Richard I. Thackray

Published in *Accident Analysis and Prevention* v2 p103-9 (1970)

46 refs

Presented at Third Triennial Congress of International Assoc. for Accident and Traffic Medicine, New York, 29 May-1 Jun 1969.

An apparatus was designed to capture that was felt to be the essential features of the "highway hypnosis" situation. Preliminary results are presented which characterize the range of behavioral psychophysiological and subjective phenomena observed with the device. The research was done first with a driving simulator and later with a simpler device which fit into the hand. This device requires response to high, middle, and low tones in a randomized sequence. Ten features considered characteristic of the highway hypnosis situation are described.

Search terms: Highway hypnosis; Psychological factors; Stress (physiology); Driver fatigue; Driving simulators; Driving task analysis; Driver performance under stress; Sounds

HS-009 781 Fld. 3/4

AROUSAL, MONOTONY, AND ACCIDENTS IN LINE DRIVING

by William N. McBain

Published in *Journal of Applied Psychology* v54 n6 p509-19 (1970)

7 refs

Lack of alertness in monotonous work situations may result from lowered arousal induced by restricted and repetitive stimulation. Line driving is held to be monotonous in this sense, hence laboratory evaluation of a driver's resistance to monotony should predict his accident record. A highly repetitive, 42-min. paced task was performed under controlled conditions by 20 truck drivers. Self-reports on monotony susceptibility, intelligence test scores, and peer ratings were obtained. Supervisory ratings, traffic convictions, and objective driving measures were obtained. Supervisory ratings, traffic convictions, and objective driving measures were criteria in addition to accident records. Accidents of one type were predicted by task errors ($r=.63$, p less than 0.1). Other relations in the correlation matrix are discussed and a tentative hypothesis advanced concerning the relations among arousal, accidents, and driver behavior.

Search terms: Highway hypnosis; Attention lapses; Driver fatigue; Truck driver performance; Accident risk forecasting; Arousal; Driving task analysis; Driver performance under stress; Intelligence; Driver tests; Driver records

3 /11 Pedestrians

HS-009 782 Fld. 3/11; 1/5

ASPECTS OF PEDESTRIAN SAFETY

by R. J. Smeed

Published in *Journal of Transport Economics and Policy* v2 n3 p1-25 (Sep 1968)

15 refs

Presented to the International Federation of Pedestrians, 19 Apr 1968.

Effects of various factors on pedestrian casualties are discussed. Pedestrian accidents in different countries are shown, including trends in accident rates, accident rates for different classes of vehicles, and the effect of age on pedestrian casualties. Measures to reduce pedestrian casualties are noted, such as segregating pedestrian traffic from motor vehicle traffic and providing safe crossing opportunities for pedestrians. The economic cost of pedestrian accidents and delay is shown in terms of time losses imposed by pedestrians on vehicular traffic and the cost of pedestrian accidents and delay compared with that of vehicle delay. The effect of darkness and weather with the number of pedestrian fatalities on dark wet nights, the effects of police presence on driver and pedestrian behavior, and the distribution of accidents are also examined.

Search terms: Pedestrian fatalities; Pedestrian safety; Pedestrian behavior; Pedestrian crossings; Accident statistics; Accident rates; Law enforcement effect on accident rates; Pedestrian accidents; Weather caused accidents; Age factor in accidents; Pedestrian age; International factors; Pedestrian crossings; Light conditions caused accidents; Accident costs; Great Britain

4/0 OTHER SAFETY-RELATED AREAS

4/5 Information Technology

HS-009 783 Fld. 4/5; 1/5

ROAD ACCIDENT TABULATION LANGUAGE (RATTLE)

by P. Harris

England Road Research Lab.

1971 42p 2 refs
Report no. RRL-LR-377

A suite of programs has been written for ICL System 4 computers to enable tabular reports from the annual road accident statistics files to be extracted with a minimum of effort. Requests for analysis are written in the form of simple language statements and punched onto cards. The system is designed for use by people with little computer experience, and the time between inception and satisfaction of requests for information has been greatly improved. The project has been extended to provide a general purpose report form analysis method using the language elements and techniques from RATTLE.

Search terms: Programming languages; Accident statistics; Automated accident records; Computer programs; Fatality rates; Punched cards

4/8 Transportation Systems

HS-009 784 Fld. 4/8

THE TRAFFIC ENGINEER'S ROLE IN REBUILDING CITIES

by William R. McGrath

Published in *Traffic Engineering* v34 n9 p12-5, 26 (Jun 1964)

Urban traffic engineers should participate directly in the urban renewal program of their cities. A natural and historical purpose of the city is to give people accessibility to one another, and this is achieved by both design and operation of movement patterns and in the configuration and details of the abutting land uses. The city of New Haven, Connecticut provides a case history of how this is possible. The key to the success of this venture is organized approach. Under the guidance of its mayor, the city developed an organization structure ten years ago which functioned then and continues now. The department heads for planning, redevelopment, city engineering, traffic engineering, off-street parking, building inspection, and housing were welded into a workable team under the budget administrator. This team confers regularly and has developed joint plans and procedures.

Search terms: Traffic engineering; Urban planning; Transportation planning; Urban renewal; Urban transportation; Parking; New Haven; Traffic management; Central business districts; Budgets

5/0 VEHICLE SAFETY

5/1 Brake Systems

HS-009 785 Fld. 5/1

SOME BRAKES ARE TOO SENSITIVE ACCORDING TO PERFORMANCE TESTS

by Rudolf G. Mortimer; Paul L. Olsen; Ralph Mosher; William F. Milliken, Jr.

Published in *Automotive Engineering* v79 n5 p31-5 (May 1971)

Average drivers consistently stop in shorter distances when their cars require significant brake pedal force to reach high decelerations than with very sensitive power brakes. Strength of weaker female limits maximum brake pedal force. Two cars with different gains and pedal compliances were tested. Results concerning loss of control, wheel lockups, deceleration, emergency stopping, and controllability are described.

Search terms: Braking forces; Braking distances; Power brakes; Brake performance; Pedal force; Female drivers; Stopping distances; Brake tests; Loss of control; Performance tests; Panic stops; Vehicle control; Wheel locking; Deceleration; Gain

HS-009 786 Fld. 5/1

WEDGE BRAKES VERSUS CAM BRAKES – THEORETICAL COMPARISON

by John W. Kourik

Wagner Electric Corp.

1964 14p 9 refs
Report no. SAE-650917

Presented at National Transportation, Powerplant, and Fuels and Lubricants Meeting, Baltimore, 19-23 Oct 1964.

This paper reviews constructions and design concepts of each brake type and the similarity of wedge geometry to that of heavy duty hydraulic brakes. Factors influencing brake effectiveness are discussed. A comparison is made of weights, response time, actuation efficiency, effect on drums, maintenance requirements, and special features including adaptability of wedge actuation to split systems.

Search terms: Brake systems; Brake design; Hydraulic brakes; Truck brakes; Brake performance; Wedge brakes; Cam brakes

AVAILABILITY: SAE

HS-009 787 Fld. 5/1

SEMI-METALLICS: A NEW TYPE OF FRICTION MATERIAL

by F. William Aldrich

Bendix Corp.

1971 6p
Report no. SAE-710591

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

A new semimetallic type of friction material has been developed which offers improved frictional stability and high temperature wear resistance. Having minimal organic content, these materials avoid the thermal sensitivity to chemical and physical change characteristics of typical friction materials. Their advantages for use in brake systems are discussed.

Search terms: Metalloids; Brake friction; Friction materials; Brake materials; Inorganic brake linings; Brake lining tests; Brake temperature; Brake fade; Brake wear; Materials tests; Wear tests; Temperature endurance tests

AVAILABILITY: SAE

HS-009 788 Fld. 5/1; 1/3

FOLLOWING DISTANCES, BRAKING CAPACITY, AND THE PROBABILITY OF DANGER OF COLLISION BETWEEN VEHICLES

by A. J. Harris

Published in *Australian Road Research Board Proceedings* 1964 v2 pt1 p496-512

16 refs
Report no. Paper-137

Presented at the third conference, Sydney.

Accident data are examined to try to form an estimate of the frequency of rear end collisions. On high speed highways, accidents sometimes occur because the driver of a following vehicle cannot stop in an emergency without overtaking the rear of the vehicle ahead. If he cannot avoid the vehicle, there is a collision, and even if he avoids it, he may have an accident by losing control of his car or hitting another vehicle. The vehicle ahead may stop very suddenly if involved in a collision, but that is not the only danger because braking capacity varies from vehicle to vehicle. The chance that the following vehicle cannot stop in time if the vehicle ahead is braked as hard as possible may be estimated from the distribution of braking capacities among vehicles. The variation of this probability with following distance, speed, and reaction time is evaluated, and the effect which large following distances would have on capacity is estimated.

Search terms: Tailgating caused accidents; Following distance; Multiple vehicle accidents; Rear end collisions; Braking distances; Braking time; Driver reaction time; Accident studies; Vehicle spacing; Headways; Deceleration; Accident risk forecasting; Traffic flow; Traffic capacity; Mathematical analysis

5/3 Cycles

HS-009 789 Fld. 5/3

MOTORCYCLE FRAME DESIGN

by David Gilbert

Published in *Automotive Design Engineering* v10 p28-30 (Jan 1971)

Until now, the design of motorcycle frames has been developed mostly through trial-and-error methods. Presently, the availability of suitable commerical computer programs has made possible proper structural analysis of frame designs. Detail design considerations leading to maximum structural efficiency are considered.

Search terms: Motorcycles; Computerized design; Frame design; Structural analysis

5/4 Design

HS-009 790 Fld. 5/4

A NEW CONCEPT IN OIL CONTROL RINGS

by K. J. Nimer

Muskegon Piston Ring Co.

1971 20p 8 refs
Report no. SAE-710547

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

A new design oil ring has been developed which shows considerable promise for the automotive piston engine. This oil ring consists of two pieces instead of the normal three. It offers improved long term oil economy, ease of installation, and lower costs.

Search terms: Oil rings; Emission control; Engine design; Oil consumption

AVAILABILITY: SAE

HS-009 791 Fld. 5/4

APPLICATION OF THE FINITE ELEMENT METHOD TO PREDICT STATIC AND DYNAMIC RESPONSE OF AN UNSHROUDED CENTRIFUGAL COMPRESSOR BLADE

by W. R. Buell; F. M. Simpson

Ford Motor Co.

1971 6p 4 refs
Report no. SAE-710554

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

A radial element centrifugal compressor vane has been analyzed by means of the Structural Analysis and Matrix Interpretive System (SAMIS). The displacement method and finite element technique were used. Initial studies of configurations where exact solutions were readily available were conducted to ensure the applicability of the method. The results of the stress analysis are presented along the deflections. The first natural frequency was also determined along with the associated mode shape and these results are also presented.

5/4 Design (Cont'd.)

HS-009 791 (Cont'd.)

Search terms: Stress analysis; Compressors; Turbine blade cooling; Structural analysis; Finite element method; Deflection; Plates; Vibration analysis

AVAILABILITY: SAE

HS-009 792 Fld. 5/4

THE MACK MAXIDYNE, ENDT865 DIESEL WITH DYNATARD ENGINE BRAKE

by J. F. Greathouse; F. J. Pekar; R. B. Gibson

Mack Trucks, Inc.

1971 14p
Report no. SAE-710557

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

Progression of the successful engine program exemplified by the Mack ENDT675 Maxidyne Six, having an essentially constant horsepower characteristic in the operating speed range, has led to the development and production of the new Mack ENDT865 Maxidyne V-8 having similarly ordered performance at higher output. Significant advances in design to maintain reliability at high loadings including a new injection pump, a simplified oil system, a single turbocharger arrangement are discussed, as well as a new integral engine brake. The Mack Dynahard Engine Brake is specifically covered in the second part of this paper.

Search terms: Diesel engines; Turbocharging; Engine design; Fuel injection; Brake system design; Lubrication systems; Engine brakes

AVAILABILITY: SAE

HS-009 793 Fld. 5/4

ROTOR DYNAMICS AND BEARING INVESTIGATIONS FOR A 10KW TURBOALTERNATOR UNIT

by T. Psichogios

International Harvester Co.

1971 10p 5 refs
Report no. SAE-710566

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

A combined analytical and experimental approach in the development of an advanced 10 kw turboalternator rotor and bearing system is described. Considerations leading to the selection of oil squeeze film damped angular contact bearings are reviewed. Unbalance response of the rotor system is covered along with a case of bearing excited fractional frequency whirl. The capabilities of the rolling element bearings are discussed, and the effects of bearing design details on fatigue life are summarized.

Search terms: Computerized design; Gas turbine engines; Computerized simulation; Bearing tests; Rotors; Turboalternators; Dynamic tests; Fatigue life

AVAILABILITY: SAE

HS-009 794 Fld. 5/4

CYLINDER HEAD DESIGN

Anonymous

Published in *Automobile Engineer* v61 n1 p16-21 (Jan 1971)

The need of limit exhaust emissions now dominates the design of cylinder heads. Progress in reducing costs has been made, but by adopting new forms of construction the cost of castings could be reduced further and the quality improved. Design criteria for cylinder heads is discussed in relation to combustion chamber design, valve and port design, valve timing, and castings.

Search terms: Exhaust emission control; Engine design; Combustion chamber design; Valves; Valve timing; Exhaust ports; Castings; Cylinder heads

HS-009 795 Fld. 5/4

AMPS AT IDLE

by Jack Steele

Published in *Fleet Owner* v66 n4 p51-6 (Apr 1971)

Alternators or generators for trucks warrant the most careful selection and maintenance. Batteries won't perform satisfactorily unless they are properly supported by an adequate charging system. The charging system must meet three requirements: (1) the battery must be kept continuously in a high state of charge; (2) cycling must be reduced as much as possible; (3) overcharging must be reduced to the absolute minimum. In the early sixties the alternator began to replace the generator. Because of simpler components, the alternator will operate up to ten times longer than a generator without service.

Search terms: Alternators; Generators; Battery charging; Truck performance; Engine operating conditions; Electric systems

HS-009 796 Fld. 5/4

RUBBER USE IN 1971 AUTOS

by Ralph Eshelman

Published in *Rubber Age* v102 n9 p67-73 (Sep 1970)

Use of rubber and rubber-like plastics for non-tire applications has increased significantly for the 1971-model cars. Applications discussed include seats, weatherstripping, power train, and cast tires. The trend toward small cars is expected to provide a sizeable new market for tires and rubber-soft plastics.

Search terms: Rubber; Plastics; Rubber consumption; Automobile materials; Cast tires; Power trains; Seats; Weatherstripping

HS-009 797 Fld. 5/4

AUTOMATIC HARDNESS TESTERS IN THE MOTOR INDUSTRY

by F. Gartner

Maier and Co. (Austria)

1971 6p 8 refs
Report no. SAE-710629

Presented at the SAE Mid-Year meeting, Montreal, 7-11 Jun 1971.

This paper describes the way in which a basic Rockwell hardness tester of speical design (a so-called Emcotest unit) can be used to achieve various stages of automation, ranging from simple multipurpose automatic standard models to fully automatic hardness test stations integrated with long-run production lines. The scope of this article has been intentionally restricted to the field of automotive engineering, although the instrument is applicable to other branches of production engineering as well as to manually operated stationary or portable appliances.

Search terms: Hardness; Steels; Automation; Production control; Test equipment

AVAILABILITY: SAE

HS-009 798 Fld. 5/4; 5/18

MAX TRAC-WHEEL SPIN CONTROL BY COMPUTER

by J. H. Moran; R. A. Grimm

General Motors Corp.

1971 11p 5 refs
Report no. SAE-710612

Prepared for presentation at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

An electronic on-board computer has been developed that controls engine power providing improved tractive effort and vehicle stability under adverse driving conditions. Using front and rear wheel speed sensor signals, the electronic controller monitors their relative speed and automatically modulates the engine power to minimize rear wheel spin, assuring stability and higher tractive effort during acceleration and cornering.

Search terms: Spin control; Wheel spinning; Traction; Speed sensors; Vehicle stability; Vehicle performance

AVAILABILITY: SAE

5/6 Fuel Systems

HS-009 799 Fld. 5/6

DEVELOPMENT OF A FUEL-BASED MASS EMISSION MEASUREMENT PROCEDURE

by Donald L. Stivender

General Motors Res. Labs.

1971 19p 21 refs
Report no. SAE-710604

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

A calculational procedure is derived which expresses exhaust emissions on a fuel basis. Existing vehicle exhaust sampling procedures are utilized, together with fuel consumption data which are simultaneously obtained. The procedure is not limited by powerplant size. Emission values are computed in terms of grams per mode and grams per mile, as well as on "corrected" molar concentration (fuel) bases. Additional calculated vehicle developmental parameters include air-fuel ratios (carbon balance and oxygen balance), air consumption, dry exhaust volume, fuel economy, and combustion efficiency. Conversion of wet exhaust analyses to dry bases is considered. Actual mass emissions are determined for both the current federal seven-mode cycle and the 1972 federal test cycle. The observed, uncorrected vehicle concentration data, with the fuel flow data obtained by means of a digital fuel meter, are reduced by means of an on-line computer installation. In addition to tests of lean, catalytic, and rich reactor vehicles, this procedure was employed for vehicles powered by gas turbine, steam, diesel, and hybrid ICE-electric power plants, including some vehicles in the 1970 "Clean Air Car Race."

Search terms: Carbon; Crankcase emissions control; Exhaust emission control; Air injection; Exhaust emission standards; Fuel combustion; Exhaust emissions measurement; Fuel economy; Nitrogen oxides; Carbon monoxide; Hydrocarbons; Gasoline mileage; Air fuel ratio; Mathematical analysis; Fuel flow; Fuel mixtures; Lean fuel mixtures; Rich fuel mixtures; Computerized test methods; Oxygen

AVAILABILITY: SAE

HS-009 800 Fld. 5/6

FACTORS INFLUENCING THE CYCLIC VARIATION OF COMBUSTION OF SPARK IGNITION ENGINE

by Shin Matsuoka; Takehisa Yamaguchi; Yukio Umemura

Tokyo Inst. of Tech. (Japan); Toyota Motor Co., Ltd. (Japan); Nissan Motor Co., Ltd. (Japan)

1971 25p 24 refs
Report no. SAE-710586

Presented at the SAE mid-year meeting, Montreal, 7-11 Jun 1971.

A statistical measurement of cyclic variation in combustion of a spark ignition engine generated by changes of mixture

5/6 Fuel Systems (Cont'd.)

HS-009 800 (Cont'd.)

conditions in the cylinder was compared with the actual measurement of variation of flow velocity and mixture ratio. From these statistical data plus further analytical study, the correlation between the combustion speed, flow velocity, and mixture ratio were shown. Combustion variation increases with the increase of combustion period. To decrease the combustion variation it is necessary to raise the combustion speed and decrease the variation of mean flow velocity in the cylinder. By measuring the curve of S(dp/dt) max versus mixture ratio, it was possible to indicate whether mixture ratio or velocity variations were causing cyclic fluctuations.

Search terms: Spark ignition engines; Internal combustion engines; Fuel mixtures; Fuel flow; Cylinders; Statistical analysis; Combustion rate; Combustion chamber swirl; Fuel combustion; Engine operating conditions; Engine performance; Pressure time histories

AVAILABILITY: SAE

HS-009 801 Fld. 5/6

PREDICTION OF TEMPERATURES ATTAINED IN A DIESEL ENGINE CYLINDER HEAD

by Rudolf Limpert

Michigan Univ.

1971 8p 6 refs
Report no. SAE-710617

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

This paper presents an engineering analysis of the temperature response of a diesel engine cylinder head. The temperature distribution attained in the cylinder head section located between the inlet and exit valve during warm-up and cyclic steady-state operation is computed employing finite difference techniques. Complicated boundary conditions, as well as the influence of the thermal state of the valves on the temperature distribution in the cylinder head, are incorporated in the analysis. Temperature response curves shown indicate good agreement between theory and practice.

Search terms: Diesel engines; Temperature; Valves; Cylinder heads; Finite element method; Engine operating conditions; Thermal factors; Heat transfer; Mathematical analysis

AVAILABILITY: SAE

HS-009 802 Fld. 5/6

HOW INDIVIDUAL VALVE TIMING EVENTS AFFECT EXHAUST EMISSIONS

by Robert M. Siewert

General Motors Res. Labs.

1971 18p 9 refs
Report no. SAE-710609

Prepared for presentation at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

The effects of individual valve timing events on the exhaust emissions of a single-cylinder engine were determined at part-load, low-speed, test conditions. The time of opening and closing of the intake and exhaust valve was varied independently over a wide range while maintaining the other three valve timing events at conventional values. Significant changes in the induction, combustion, and exhaust processes resulted from valve timing changes. Of particular interest are the changes in engine exhaust emissions of hydrocarbons and nitric oxide under part load operation. The interactions between numerous engine parameters and valve timing are also discussed. Engine load, speed, spark advance, exhaust pressure, intake system configuration, mixture temperature and external exhaust gas recirculation effects are included in this paper.

Search terms: Exhaust emission tests; Exhaust valves; Valve timing; Air pollution emission factors; Single cylinder engines; Exhaust gases; Intake valves; Exhaust gas recirculation; Nitric oxide; Hydrocarbons

AVAILABILITY: SAE

HS-009 803 Fld. 5/6; 4/7

ANALYTICAL SIMULATION OF FUEL INJECTION IN DIESEL ENGINES

by G. A. Becchi

Fiat S.P.A.

1971 31p 16 refs
Report no. SAE-710568

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

The increase of specific output in diesel engines which has developed lately, and the need for a quick response to the market requirements, has imposed remarkable changes in the design of the diesel engine components. This has also resulted in a change in the design of injection equipment. In fact, the dimensioning of the equipment as a simple definition of geometrical and mechanical characteristics of the various components in the designing phase has been replaced by the necessity to single out possible operation faults and to define the measures necessary for their elimination. This is possible only with the aid of highly improved calculation methods, suitable to simulate as accurately as possible the phenomena to be identified. The calculation method discussed in this paper was carried out on the basis of these considerations.

Search terms: Fuel injection; Diesel engines; Computerized design; Computerized simulation; Equations of equilibrium

AVAILABILITY: SAE

HS-009 804 Fld. 5/6; 5/4

MOTOR'S "MOTORING PLUS" TUNING AND CONVERSION GUIDE. PT. 2. BOLT-ON KITS BEFORE AND AFTER

Published in *Motor* (London) v139 n3584 p17-32 (13 Mar 1971)

Conversion kits for improving engine performance are described. Kits are described for the Triumph 1300, the Hillman Avenger 1500, the Hillman Californian, the Austin Maxi 1500, the Volkswagen 1200, the 850 cc Austin Mini, the Vauxhall Viva 1600, the Fiat 128. Speed, acceleration, and fuel consumption with and without the kits are described. Supercharging, fuel injection, electronic testing, spot-on tuning, and transistorized ignition kits are also discussed.

Search terms: Fuel injection; Superchargers; Engine performance; Tune-up; Engine modification; Engine tests; Transistors; Engine conversion; Fuel consumption; Engine speeds; Acceleration; Speed patterns; Ignition

HS-009 805 Fld. 5/6; 5/4

NEW ENERGY-ABSORBING MATERIALS FOR CRASH-RESISTANT FUEL TANKS

by W. C. McDonald

Goodyear Aerospace Corp.

1968 5p
Report no. SAE-680210

Presented at Business Aircraft Meeting, Wichita, 3-5 Apr 1968.

This paper discusses the work that the Engineering Div. of Goodyear Aerospace Corp. has been conducting in energy-absorption and how this has been applied to new concepts in fuel containment. The discussion includes various qualitative test methods and compares the test values of the material being investigated to standard fuel tank materials. Hopefully, these values will suggest new design approaches and test procedures for the improvement of fuel tanks, both in crash-resistance and puncture sealing ability.

Search terms: Energy absorbing materials; Crashworthy fuel tanks; Fuel tank rupture; Fuel tank tests; Materials tests

AVAILABILTY: SAE

5/10 Lighting Systems

HS-009 806 Fld. 5/10

MULTI-BRAKELIGHT ARRAY CONTROL EQUIPMENT

by J. S. Armour; I. D. Carter

England Road Research Lab.

1971 17p 1 ref
Report no. RRL-LR-374

The equipment described in this report was developed for the evaluation of multi-brakelight displays. Basically it consists of an array of lights which can be switched on in accordance with the vehicle's deceleration. The apparatus can be readily programmed to sequentially display a number of groups of lamps in response to present values of vehicle deceleration. Each group of lamps consists of 1, 2, or 3 lamps and the total display can consist of up to 7 such groups. Vehicle deceleration is sensed at three separate levels within the range 0-1g each level controlling the operation of from 1 to 7 lamp groups. The equipment may be operated in either of two modes, the lamps can be lit during the deceleration period only or remain lit until the vehicle throttle is next operated. Visual indication of the operation of the display is presented to the experimenter within the vehicle and provision is made for permanent recording by a multi-channel recorder. The equipment can be used on vehicles of any length and, being electrically isolated, is independent of vehicle chassis polarity.

Search terms: Electric systems; Electric system design; Brake lamps; Deceleration lamps

HS-009 807 Fld. 5/10; 2/5

AN EFFECTIVE MEANS OF INCREASING HIGHWAY ILLUMINATION AND REDUCING THE HEADLIGHT GLARE

by Merrill J. Allen

Published in *Journal of the American Optometric Association* v34 n3 p225-6 (Oct 1962)

Road illumination could be increased by putting auxiliary lighting on the car instead of lighting the highway with fixed luminaires. A study was undertaken to find the proper location for this auxiliary lighting and the best direction for the beam. Conventional 5-½" sealed beam dual filament headlamps wer tested and found most satisfactory. A low position at bumper level gave twice the light reflected from the pavement toward oncoming cars as was obtained from a high position on top of the vehicle. A backward direction of the beam was far superior to a forward direction. Auxiliary lighting could be wired into the low passing beams. Further study, especially under conditions of rain and fog, is indicated.

Search terms: Auxiliary lamps; Sealed beam headlamps; Highway lighting; Headlamp glare; Headlamp mounting height; Headlamp tests

5/12 Manufacturers, Distributors, and Dealers

HS-009 808 Fld. 5/12

SPECIFICATIONS AND TESTS IN THE DEVELOPING COUNTRIES – WHY, WHEN, WHAT AND HOW

by Robert E. Wallace; Jesse B. Vargas; James E. Miller

5/12 Manufacturers, Distributors, and Dealers (Cont'd.)

HS-009 808 (Cont'd.)

Dow Quimica Argentina; Dow Chemical Latin America

1971 6p
Report no. SAE-710657

Presented at the Joint Meeting of SAE Mid-Michigan section and American Chemical Society Midland Section, Midland, Mich., 24 Oct 1970.

The world over and especially in the developing countries, the automobile has become a necessary addition to the way of life. However, it is hoped that the specifications and test procedures which are government approved and used widely throughout the United States and Europe will not be imported into the developing countries, since performance requirements for individual components and vehicles may vary widely from country to country. Therefore, closer cooperation is necessary between government, vehicle manufacturers, suppliers of parts and material in order to establish and coordinate specifications which will fit the special needs of each country.

Search terms: Automobile production statistics; Automobile prices; Manufacturing standards; Tests; Specifications; Developing countries; Automotive industry; Government industry cooperation; Performance characteristics; International factors

AVAILABILITY: SAE

5/14 Occupant Protection

HS-009 809 Fld. 5/14

CHRYSLER HOPES "SUPER-CUSHION" FILLS NEED FOR PASSIVE RESTRAINT

by Roy Haeusler

Published in *Automotive Engineering* v79 n5 p17-20 (May 1971)

Chrysler has designed a restraint system that offers the same protection to passengers as their collapsible steering column offers the driver. It is a passive system consisting of a knee restraint panel which absorbs energy and limits forward motions, and chest level energy absorbing cushions made of tubular containers filled with plastic foam or thin-wall metal tubes. The cushions have been tested with dummies and seem to offer protection close to that offered by the air bags under ideal conditions. Moreover, the cushions are always available, without delay for detection and actuation, and they don't have the reliability problems of sensitive and sophisticated actuators. Finally, the cost of the cushions may be half the cost of any feasible system involving split second actuation.

Search terms: Cushioning; Occupant protection; Passive restraint systems; Energy absorbing materials; Air bag restraint systems; Impact tests

HS-009 810 Fld. 5/14

PADDING MATERIALS FOR HEAD IMPACT PROTECTION

by S. R. Sarrailhe

Australian Defence Scientific Service

Jul 1968 36p 19 refs
Report no. ARL/SM-321

This study was carried out as part of the crash safety research program supported by the Department of Civil Aviation of Australia. Data on the tolerance of the head to impact are reviewed and design forces for padding suggested. The effects of padding thickness and material properties are discussed and ways of selecting materials are indicated. Results of tests on materials available in Australia are discussed.

Search terms: Impact protection; Occupant protection; Padding tests; Energy absorbing materials; Head impact velocity; Head acceleration tolerances; Materials tests; Head protection; Head impact tolerances; Helmets

HS-009 811 Fld. 5/14; 1/2; 1/5

CAN THE EFFECT OF CHANGES IN VEHICLE DESIGN BE SEEN IN MASS ACCIDENT DATA?

by James O'Day; Jay S. Creswell, Jr.

Published in *HIT Lab Reports* p1-9 (Feb 1971)

refs

Condensation of paper presented to American Assoc. of Automotive Medicine 14th annual meeting.

Two approaches to evaluating the effect of improved occupant protection in newer model passenger vehicles are presented along with a theoretical framework for evaluation. Several sets of accident data were examined to determine if occupants of newer vehicles sustain fewer or less severe injuries than occupants of older vehicles involved in similar types of crashes. The theoretical computations indicated that for moderate improvements, say a 10% reduction in the injury probability per accident, the total number of fatalities will continue to increase although at a reduced rate; this increase is due to growth in the vehicle population. For major improvements, on the order of a 50% reduction, the total number of fatalities and the vehicle fatality rate will drop. The data analysis indicated that newer, 1968-1969, model vehicles tend to be within the 10% improvements range compared to those vehicles manufactured in previous years.

Search terms: Occupant protection; Impact protection; Safety design; Accident statistics; Fatality rates; Impact protection; Passenger injuries; Driver injuries; Injury prediction; Injury severity; Restraint systems; Statistical analysis; Safety device effectiveness; Automobile design; Automobile safety characteristics; Vehicle age; Automobile models; Energy absorbing steering columns

HS-009 812 Fld. 5/14; 4/7

MODELING TOOLS FOR DESIGN OF AIR CUSHION RESTRAINT SYSTEMS

by F. J. Irish; R. A. Potter; R. D. McKenzie

General Motors Corp.

22p 6 refs
Report no. SAE-710015

Prepared for presentation at International Automotive Engineering Congress, Detroit, 11-15 Jan 1971.

An air cushion restraint system study was conducted to develop and experimentally verify mathematical models of selected air cushion restraint systems; to provide a method for simulating the dynamic interaction between occupants and restraint system during an automobile collision, and to develop an efficient means for conducting system performance tradeoff studies of promising system concepts. All of the models individually and in combination provide a comprehensive design analysis capability useful in the evaluation of air cushion restraint systems. This capability permits parameter studies of a wide range of vehicle, sensor, inflation and occupant combinations, thus reducing the time and number of hardware tests required to converge on the most optimum system configuration. Improvements in cushion pressure and temperature measurement techniques are needed to permit more accurate correlation of the air cushion model.

Search terms: Mathematical models; Air bag restraint systems; Computerized simulation; Occupant kinetics; Air bag inflation systems; Accident simulation; Sensors

AVAILABILITY: SAE

5/15 Propulsion Systems

HS-009 813 Fld. 5/15; 5/6

POLLUTION REDUCTION WITH COST SAVINGS. A REPORT ON THE GENERAL SERVICES ADMINISTRATION'S DUAL-FUEL VEHICLE EXPERIMENT

General Services Administration

1971 28p
Report no. GSA-DC-71-10828

A fleet of low-polluting, natural gas-fueled vehicles was tested to demonstrate reduced emissions and costs. The reduction in pollutants was 82% for hydrocarbons, 87% for carbon monoxide, and 53% for oxides of nitrogen. Lead was eliminated and particulates reduced nearly to zero. These results meet all new vehicle standards up to 1975. Cost reduction is also discussed. Automobiles, light trucks, and medium trucks were used in the tests.

Search terms: Dual fuel vehicles; Exhaust emission tests; Exhaust emission control; Exhaust emissions measurement; Exhaust emission standards; Natural gas automobiles; Hydrocarbons; Carbon monoxide; Nitrogen oxides; Natural gas vehicles; Lead; Particulate air pollutants; Vehicle operating costs; Truck tests

5/22 Wheel Systems

HS-009 814 Fld. 5/22

TYRES FOR COMMERCIAL VEHICLES

by D. R. Henson

Published in *Rubber and Plastics Age* v45 n11 p1331-4 (1964)

Factors of importance in the performance of tires are discussed: tread life; speed performance; wet road grip; fuel economy; vehicle ride. Speed recommendations for commercial and public service vehicle tires are given. Priority of performance for specific operations is indicated: for light truck tires, giant tires, passenger service vehicle tires, on-and-off road tires, and tires for using overseas.

Search terms: Tire performance; Speed; Tire wear; Tire selection; Tire sizes; Tire traction; Tire treads; Fuel economy; Tire characteristics; Truck tires; Commercial vehicles; Vehicle riding qualities; Wet road conditions

HS-009 815 Fld. 5/22

FORCES AND DISPLACEMENT IN CONTACT AREA OF FREE ROLLING TIRES

by N. Seitz; A. W. Hussmann

Metzeler A.G. (West Germany); Technische Hochschule, Munich (West Germany)

1971 8p 11 refs
Report no. SAE-710626

Presented at the SAE mid-year meeting, Montreal, 7-11 Jun 1971.

Of all the automobile safety studies made, one that has received much attention is tire design. Comfort, service life, and reliability have been the guideposts in the development of better and safer tires. The investigation of the forces that affect reliability is the subject of this paper, and emphasis is placed on determination of the parameters at the particular area where tire and road are in contact.

Search terms: Tire design; Tire test equipment; Tire performance; Parameters; Tire road contact forces; Coefficient of friction; Tire wear; Reliability

AVAILABILITY: SAE

HS-009 816 Fld. 5/22; 2/4

TIRE TRACTION MEASUREMENT ON THE ROAD AND IN

5/22 Wheel Systems (Cont'd.)

HS-009 816 (Cont'd.)

THE LABORATORY

by Walter Bergman; Harold R. Clemett; Narendra J. Sheth

Ford Motor Co.

1971 23p 23 refs
Report no. SAE-710630

Presented at the SAE Mid-Year Meeting, Montreal, 7-11 Jun 1971.

This paper gives a comprehensive analysis of tire-road traction, utilizing new experimental and analytical techniques. It introduces a concept of traction envelope for evaluation of the overall tire traction properties in all operating models on a common basis. It establishes feasibility of laboratory techniques for tire wet traction measurements and shows good correlation between road and laboratory measurements and also between road measurements on different surfaces. Comparative evaluation between new and conventional techniques for measuring tire traction on the road in cornering with and without power application are given.

Search terms: Tire traction; Tire tests; Pavement surface texture; Laboratory tests; Road tests; Wet road conditions; Cornering; Tire pavement interface

AVAILABILITY: SAE

HS-009 817 Fld. 5/22; 2/7

TYRE PERFORMANCE IN WET SURFACE CONDITIONS

by G. C. Staughton; T. Williams

England Road Research Lab.

1970 89p 18 refs
Report no. RRL-LR-355

This report gives the results of an investigation of the tire road adhesion of a single wheel towed through various depths of water. At water depths above about 4 mm the freely rolling wheel tended to spin down and this occurred at lower speeds as the tire inflation pressure was reduced. When the wheel was locked the tire road adhesion also reduced at the lower inflation pressures. The greatest loss in adhesion occurred between the dry surface and the lightly wetted surface, with increasing reduction in adhesion as the water depth was increased to 4 mm; at depths greather than this the adhesion values were already close to the minimum. The adhesion also decreased with speed, for example, a drop of 0.3 braking force coefficient occurred on the smooth concrete surface as the speed was increased from 50 to 120 km/h for a 4 mm water depth with a patterned tire. Stopping distances for this water depth can be at least double those for a just wet surface. Some further tests showed that adhesion on a rough harsh textured surface was also affected by water depth.

Search terms: Tire performance; Tire pavement interface; Tire road conditions; Adhesion; Tire traction; Tire test equipment; Wet road conditions; Tire inflation pressure; Tire tests; Pavement surface texture; Braking forces; Wheel locking friction; Hydroplaning

HS-009 818 Fld. 5/22; 4/7

PASSENGER TIRE POWER CONSUMPTION

by D. R. Elliott; W. K. Klamp; W. E. Kraemer

Uniroyal Tire Co.

1971 15p
Report no. SAE-710575

Presented at SAE mid-year meeting, Montreal, 7-11 Jun 1971.

The rolling resistance of a tire can have a marked effect on such factors as gasoline mileage and high speed durability. In an effort to understand better the mechanisms involved, 80 tires were analyzed. This analysis resulted in dividing the rolling resistance into a component (R_a) independent of speed, and a component (R_b), which is very speed dependent. The body of this paper discusses the effect of of operating conditions and tire design variations on both of these components.

Search terms: Tire rolling resistance; Tire road contact forces; Tire loads; Speed; Tire tests; Tire materials; Tire characteristics; Tire inflation pressure

AVAILABILITY: SAE

5/23 Windshield-Related Systems

HS-009 819 Fld. 5/23

AUTOMOBILE DEFROSTER PERFORMANCE DURING A CANADIAN WINTER

by G. F. W. McCaffrey

Canada National Aeronautical Establishment

Jun 1968 61p
Report no. MS-119

A group of six typical automobiles was subjected to a standardized test of defroster performance and subsequently monitored during normal driving from November 1967 to March 1968, in an attempt to evaluate the performance of defroster systems in Canadian winter driving conditions. It would appear that most winter driving trips are of about 20 minutes length. It takes a warm-up period of about 20 minutes for effective defrosting. A method to achieve more rapid warm-up of the system should be sought. Recommendations for improvement are given.

Search terms: Cold weather tests; Winter driving; Visibility; Performance tests; Reduced visibility; Defrosters; Canada; Cold weather starting; Laboratory tests; Field tests; Windshields; Trip length

NHTSA DOCUMENTS

NHTSA Accident Investigation Reports

HS-600 519 Fld. 1/5

MULTIDISCIPLINARY ACCIDENT INVESTIGATION SUMMARIES. VOL. 2, NO. 2

National Hwy. Traf. Safety Administration

Apr 1971 212p

The full reports are not being announced in *Highway Safety Literature,* but are available for inspection at NHTSA Reference Div.; or for purchase from NTIS.

In-depth studies of highway crashes are being conducted to identify contributing factors and injury causation, to evaluate the effectiveness of countermeasures, and to detect design and functional problems of the vehicle and the highway. Summaries of 50 case reports are given.

Search terms: Accident case reports; Accident analysis; Accident causes; Accident factors; Accident investigation; Accident location; Damage severity; Injury severity; Injury causes; Multidisciplinary teams; Accident prevention; Injury factors; Time of accidents; Environmental factors; Accident types; Precrash phase; Crash phase; Postcrash phase; Vehicle design; Highway design

AVAILABILITY: NTIS

NHTSA Contractors Reports

HS-800 486 Fld. 1/3

ACQUISITION OF INFORMATION ON EXPOSURE AND ON NON-FATAL CRASHES. VOL. 1, EXPOSURE SURVEY CONSIDERATIONS. FINAL REPORT

by P. S. Carroll; W. L. Carlson; T. L. McDale; D. W. Smith

Michigan Univ. Hwy. Safety Res. Inst.

12 May 1971 131p 19 refs
Contract FH-11-7293
Report no. HSRI-03169-1

Report for Jun 1969–Mar 1971.

An analysis of the considerations involved in the design of driving-exposure surveys is presented. Exposure is defined as the frequency of traffic events which create a risk of accident, measured in vehicle miles of travel. Exposure data obtained in a survey may be combined with accident data to derive accident rates, for use in evaluating highway safety countermeasures. Exposure estimates from a random sample were analyzed, and six variables were chosen as best predictors of exposure (driver sex, driver age, vehicle type, model year, day/night, and road type); 26 unique classes of these variables were defined. Small auxiliary surveys were performed to test the effectiveness of various survey methods. The mail questionnaire method (using one-day trip records) was selected as the best, based on cost and accuracy. Interview methods were also considered. Final recommendations include the implementation of a national exposure survey field test in 1972 at a cost of about $250,000, and continuing operational surveys on an annual basis.

Search terms: Accident risks; Highway accident potential; Accident risk forecasting; Statistical analysis; Sampling; Surveys; Safety research; Data acquisition; Vehicle mileage; Driver sex; Driver age; Vehicle age; Vehicle classification; Highway classification; Accident studies; Day vs night accident risks

AVAILABILITY: NTIS, as PB-201 414

HS-800 487 Fld. 1/3

ACQUISITION OF INFORMATION ON EXPOSURE AND ON NON-FATAL CRASHES. VOL. 2. ACCIDENT DATA INACCURACIES. FINAL REPORT

by R. E. Scott; P. S. Carroll

Michigan Univ. Hwy. Safety Res. Inst.

12 May 1971 86p 16 refs
Contract FH-11-7293
Report no. HSRI-03169-2

Report for Jun 1969-Mar 1971.

This volume presents information on inaccuracies in existing sources of highway accident data, on methods for correcting these inaccuracies, and on methods for improving accident injury data by use of hospital records. The major error in existing accident data is bias due to under-reporting; this is due to lenient criteria and policies for reporting of accidents. It was determined that corrections in accident-frequency totals may be accomplished by extrapolations of reported totals, using ratios of non-reporting derived from sample comparisons between official records and driver surveys. Also, available national summaries of hospital records could be used to improve estimates of the number and severity of accident injuries.

Search terms: Accident risks; Highway accident potential; Accident risk forecasting; Statistical analysis; Surveys; Safety research; Accident studies; Accident investigation; Accident investigation training; Injury severity; Data acquisition; Injury prediction; Hospital records; Accident statistics

AVAILABILITY: NTIS, as PB-201 415

HS-800 488 Fld. 1/3

ACQUISITION OF INFORMATION OF EXPOSURE AND ON NON-FATAL CRASHES. VOL. 3. PROCEDURES FOR AN EXPOSURE SURVEY. FINAL REPORT

by P. S. Carroll; T. L. McDole; W. L. Carlson; P. S. Samarco

NHTSA Contractors Reports (Cont'd.)

HS-800 488 (Cont'd.)

Michigan Univ. Hwy. Safety Res. Inst.

12 May 1971 67p
Contract FH-11-7293
Report no. HSRI-03169-3

Report for Jun 1969-Mar 1971.

This volume presents detailed procedures for an annual, national survey of driving exposure, based on mailed questionnaires to a random sample of licensed drivers in the 50 states and District of Columbia. The total sample size is 28,000 and subsamples in each state are proportional to the number of licensed drivers. Each questionnaire requires information on driver age and sex, plus a one-day trip record indicating vehicle type, model year, road type, day or night, and trip mileage. Each trip is subsequently classified in one of 26 unique driver-vehicle-road-environment combinations. The sample size assures a minimum significant difference of approximately 30-40 percent between mileage estimates of any two classes. The procedure plans include details of sampling, data collection, and analysis covering a 22 month period.

Search terms: Accident risks; Highway accident potential; Accident risk forecasting; Statistical analysis; Sampling; Surveys; Safety research; Data acquisition; Questionnaires

AVAILABILITY: NTIS, as PB-201 416

HS-800 489 Fld. 1/3

ACQUISITION OF INFORMATION ON EXPOSURE AND ON NON-FATAL CRASHES. VOL. 4. APPENDICES. FINAL REPORT

by P. S. Carroll; T. L. McDole; W. L. Carlson; R. E. Scott

Michigan Univ. Hwy. Safety Res. Inst.

12 May 1971
Contract FH-11-7293
Report no. HSRI-03169-4

Report for Jun 1969-Mar 1971.

This volume contains appendices relating to main text sections of the first three volumes of this study. They include the contract statement of work, survey questionnaires, details of the pilot survey, derived survey variables, AID charts of classification analysis, statistical significance and analysis of precision of pilot survey data, advantages and disadvantages of survey alternatives, survey reminder letters, state codes and subject number ranges, alternative data analysis model, abbreviated injury scale, and classification of injury.

Search terms: Surveys; Statistical analysis; Sampling; Accident risks; Accident risk forecasting; Safety research; Data acquisition; Accident studies; Accident investigation; Injury severity index; Questionnaires

AVAILABILITY: NTIS, as PB-201 417

HS-800 490 Fld. 1/3

ACQUISITION OF INFORMATION ON EXPOSURE AND ON NON-FATAL CRASHES. VOL. 5. EXECUTIVE SUMMARY. FINAL REPORT

by Philip S. Carroll

Michigan Univ. Hwy. Safety Res. Inst.

12 May 1971 23p
Contract FH-11-7293

Report no. HSRI-03169-5

Report for Jun 1969–Mar 1971.

This volume presents summaries on each of the three phases of the study. In Phase I, dealing with exposure survey considerations, analyses were performed on classifications of exposure data and procedures for exposure surveys. A pilot survey of driving exposure (vehicle miles of travel) was performed and six variables were determined as best predictors of exposure: driver sex and age, vehicle types and model year, roadway type, and day vs. night. Considerations of cost and accuracy among various methods for exposure surveys led to a recommendation of annual, nationwide surveys using mailed questionnaires and one-day trip records by randomly sampled drivers. In Phase II, dealing with accident data inaccuracies, data from a survey of drivers was compared with driver's official records to determine underreporting bias. Results may be used to make corrections in accident data. A technique for correcting accident injury data, based on hospital records, was considered. In Phase III, detailed procedures were determined to implement a national exposure survey in 1972.

Search terms: Accident risks; Highway accident potential; Accident risk forecasting; Surveys; Safety research; Accident studies; Data acquisition

AVAILABILITY: NTIS, as PB-201 418

HS-800 500 Fld. 3/1

A SYSTEMS APPROACH TO THE ANALYSIS OF THE DRINKING DRIVER CONTROL SYSTEM. FINAL REPORT. VOL. 1

by Kent B. Joscelyn; Ralph K. Jones

Indiana Univ.

1 May 1971 117p refs
Contract FH-11-7270
Report no. FH-11-7270-71-6

Report for 1 Jun-30 Nov 1970.

The social process aimed at controlling the drinking driver is diffuse and ill-organized, but is susceptible to analysis and improvement by techniques of systems engineering. These techniques suggest that the drinking driver control system consists of five top-level functions: legislation, enforcement, adjudication, sanctions, and treatment. Measurement of the present performance of

these functions shows that the system is less effective than it could be, mainly because the separate functions lack common and clear objectives and purposeful, coordinated management. These conclusions stem from analysis of quantitative and descriptive data concerning Fairfax County, Va., and Indianapolis, Ind. By standardized procedures for determining system objectives, and by the development of universally applicable measures of effectiveness, the points of system "failure" can be clearly identified, many in quantitative terms. The present system can then be engineered so as to increase its efficiency on the basis of high-risk identification and cost-effectiveness.

Search terms: Systems analysis; Drinking drivers; Driver intoxication; Benefit cost analysis; Alcohol laws; Law enforcement; Alcohol usage deterrents; Alcoholism; Arrests; Problem drivers; Accident factors; Blood alcohol levels

AVAILABILITY: NTIS, as PB-201 593

HS-800 501 Fld. 3/1

A SYSTEMS APPROACH TO THE ANALYSIS OF THE DRINKING DRIVER CONTROL SYSTEM. FINAL REPORT. VOL. 2. THE DRINKING DRIVER AND HIGHWAY SAFETY, A REVIEW OF THE LITERATURE

by Kent B. Joscelyn; Ralph K. Jones

Indiana Univ.

1 May 1971 138p 174 refs
Contract FH-11-7270
Report no. FH-11-7270-71-7

Report for 1 Jun-30 Nov 1970.

This volume consists of a survey and summaries of selected published research concerning drinking drivers, the problems they create in traffic safety and law, and methods of controlling their behavior. The survey summarizes information from 174 documents to determine the extent of the driving-while-intoxicated (DWI) problem, the methods used by the traffic law system and other agencies to handle the problem, the effects of various countermeasure programs and, in general, the current state of knowledge about the DWI problem. The survey approaches its subject from five viewpoints: legislation to control the drinking driver; enforcement of DWI legislation; adjudication of DWI cases by courts and administrative agencies; sanctions applied against convicted DWI offenders; and treatment alternatives. Also included is a summary of the current state of research into alcohol and the role of drinking drivers in traffic accidents.

Search terms: Systems analysis; Drinking drivers; Reviews; Driver intoxication; Alcohol laws; Law enforcement; Alcohol usage deterrents; Penalties; Courts; Alcoholism; Accident factors; Problem drivers; Alcohol effects; Alcohol usage

AVAILABILITY: NTIS, as PB-201 594

HS-800 502 Fld. 3/1; 4/1

A SYSTEMS APPROACH TO THE ANALYSIS OF THE DRINKING DRIVER CONTROL SYSTEM. FINAL REPORT. VOL. 3. THE PROBLEM DRINKING DRIVER, A LEGAL PERSPECTIVE

by Kent B. Joscelyn; Ralph K. Jones

Indiana Univ.

1 May 1971 98p
Contract FH-11-7270
Report no. FH-11-7270-71-8

Report for 1 Jun-30 Nov 1970.

Investigation was made of the statutory law, the common law, and the administrative law affecting the relationship between the person who drives while intoxicated and the traffic law system, under FH-11-7270, A Systems Analysis of the Traffic Law System. Specific attention was paid to the jurisdictions of Marion County, Indian, and Fairfax County, Virginia. The discussion attempts to blend law and real world situations, emphasizing efforts of the traffic law system to reduce the number of highway deaths caused by drinking drivers.

Search terms: Drinking drivers; Alcohol laws; Problem drivers; Systems analysis; Traffic laws; Legal factors; Penalties; Driver intoxication; Arrests; Alcohol chemical tests; Implied consent laws; Driver license revocation

AVAILABILITY: NTIS, as PB-201 595

HS-800 503 Fld. 3/1

A SYSTEMS APPROACH TO THE ANALYSIS OF THE DRINKING DRIVER CONTROL SYSTEM. FINAL REPORT. VOL. 4. CASE STUDIES.

by Kent B. Joscelyn; Ralph K. Jones

Indiana Univ.

1 May 1971 184p
Contract FH-11-7270
Report no. FH-11-7270-71-9

Report for 1 June-30 Nov 1970.

Case studies in Fairfax County, Virginia, and Indianapolis, Indiana, were conducted to describe the Driving-While-Intoxicated Control System (DWICS), in the form of quantitative and qualitative descriptions as related to FH-11-7270, A Systems Analysis of the Traffic Law System. The study indicates that the existing ability of the police to detect and apprehend drinking drivers is so marginal as to be almost completely ineffective as a countermeasure, if the Fairfax County experience is considered representative. The sociological characteristics of drinking drivers and the police procedures used in dealing with them are described.

Search terms: Systems analysis; Drinking drivers; Alcohol laws; Prob-

NHTSA Contractors Reports (Cont'd.)

HS-800 503 (Cont'd.)

blem drivers; Driver intoxication; Case reports; Alcoholism; Driver characteristics; Police; Arrests; Sociological factors; Alcohol usage deterrents

AVAILABILITY: NTIS, as PB-201 596

HS-800 508 Fld. 4/5; 1/5; 2/11

TRAFFIC RECORDS SURVEY OF FEDERAL AGENCIES. FINAL REPORT

Booz-Allen Applied Res., Inc.

1 May 1971 37p
Contract FH-11-7625

This survey was conducted to identify Federal department and agency records related to motor vehicle and traffic safety. Sixteen departments/agencies were contacted and 95 record files located which contain data and information on accidents, drivers, mechanics, and vehicle maintenance and repair. The survey was conducted at two levels of intensity: (1) low-intensity inventories provided identification of record files and a summary of file descriptions; (2) high-intensity inventories provided additional information on file use, reports generated, and detailed identification of the data elements within the file. Federal forms (BOB/OMB) and departmental forms were identified with respect to each file. Results of this survey indicate that accident reporting requirements vary; same/similar forms are used; records may be regionally or centrally located; and some safety management functions utilize automatic data processing for file manipulation and safety studies.

Search terms: Accident records; Driver records; Accident statistics; Traffic records; Information systems; Accident reports; United States Government; Surveys; Records; Vehicle registration; Driver statistics; Accident report forms

AVAILABILITY: NTIS, as PB-201 553

executive summary

NPOSIS OF A RECENTLY RELEASED NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION RESEARCH REPORT

VEHICLE HANDLING TEST PROCEDURES
FINAL REPORT

The purpose of this study was to develop objective procedures for measuring safety related aspects of the dynamic performance of passenger motor vehicles.

Contract FH-11-7297
Highway Safety Research Institute
University of Michigan
Huron Parkway & Baxter Road
Ann Arbor, Michigan 48105
DOT/HS-800 374 Volume I, Final Report PB-196 953
DOT/HS-800 375 Volume II, Summary PB-196 954

Award Amount: $200,065.00
Contract Period: June 20, 1969 to March 1, 1971

General Comments

It is recognized that the complex relationship between vehicle handling performance and highway safety is neither theoretically understood nor experimentally documented. There is nonetheless ample intuitive basis to hypothesize that such a relationship exists and, further, that there are certain specific performance characteristics of motor vehicles which, during either the normal driving process or during emergency situations, cause the potential for loss of control to rise above a threshold beyond which driver skill and experience are of little avail. The problem remains to (1) identify such safety-relevant performance qualities, and (2) develop reliable, objective procedures for their measurement.

Since, as noted above, connections between vehicle handling performance and safety must presently be based on intuition, the approach adopted herein may be categorized as pragmatic. Such an approach is a proper response to the sponsor's immediate objective, namely, establishment of interim standards for vehicle handling, but certainly no substitute for basic studies of the driver/vehicle system required to gain real understanding of the performance/safety relationship.

Following the introduction, Section 2.0 of the report discusses the approach in greater detail, attempting to articulate a rational pragmatic viewpoint and to develop from it a consistent and meaningful framework for the definition of handling test procedures. Within this framework, a broad spectrum of considerations ranging from theoretical vehicle mechanics to practical automotive engineering enables us to identify those particular performance qualities viewed as having first-order safety relevance.

Section 3.0 of the report describes the design and conduct of a pilot test program consisting of experiments to measure each of the designated performance qualities for a sample of vehicle configurations of widely designed to measure vehicle response characteristics independent of the confounding actions of a test driver or drivers. To this end, and to facilitate the precise application of control inputs of prescribed form, certain of the more extreme and complicated experiments involve the use of an automatic control system to manipulate the vehicle's steering, braking, and accelerating controls. The design and operation of this system, considered to represent a uniquely valuable tool for the safety-related evaluation of the motor vehicle, are described in substantial detail.

In Section 4.0 the pilot test results are presented and analyzed to illustrate and rationalize the derivation of

safety-related performance measures from the data. The results of supplementary vehicle tests performed especially for the purpose, and the output of a hybrid computer study involving over 1400 simulation runs, are employed to help interpret and generalize the basic data in this context. The major conclusions reached are reviewed below and are summarized in Section 5.0. They appear mainly in the form of a recommended set of test procedures which effectively define the scope and format of a vehicle handling standard. Specific recommendations for additional research associated with the development and implementation of such a standard are also presented.

The report has two appendices. The first describes and illustrates the analysis of vehicle-usage survey data to derive realistic ranges of service factors – tire inflation pressure and vehicle loading – to be considered in an evaluation of vehicle performance. The second describes the hybrid simulation model employed in the study, and presents comparative experimental and theoretical results to illustrate the degree of validity of the model.

MAJOR CONCLUSIONS AND RECOMMENDATIONS

Methods of testing and data analysis have been demonstrated which provide objective and discriminating procedures for measuring these safety-relevant characteristics. Particularly notable is the development of an automatic controller which permits the conduct of severe handling tests heretofore impossible because of the limitations of the human controller.

Recommend Threefold Program

With respect to the ultimate goal of the study, viz., implementation of a vehicle handling performance standard, much work remains to be done. A logical first step is the conduct of a more general test program to measure the performance characteristics defined here for a much broader cross-section of passenger vehicles. The purpose of such a program would be threefold:

1. To refine and augment the developed procedures with the aid of additional test experience and data.

2. To more precisely define the precision and discriminatory power of the proposed performance measures.

3. To produce a data base defining the performance characteristics of the passenger vehicle population, which would serve as a basis for accident causation studies and, ultimately, for the establishment of minimum performance requirements.

Procedures Developed

Procedures developed in this program are intended to constitute a recommendation for the format of handling tests to be performed in an expanded pilot program. It is implicit in their definition that these tests would be supplemented by a comprehensive program of tire traction measurements.

○ Recommended Vehicle Handling Measurements

1. Straight line braking effectiveness – to the limit of tire-road adhesion – two pavement conditions; dry concrete and wet, painted asphalt – two loading conditions.

2. Response to step steering input – to the limit of tire-road adhesion – to characterize the breakaway condition in terms of peak lateral acceleration and continuity of yaw response – two service factor conditions: nominal and off-design.

3. Braking effectiveness from a steady-turn initial condition – to provide a generalized braking efficiency characterization involving a measure of the deviation of vehicle trajectory (from its nominal circular path) produced by braking – to the limit of tire-road adhesion – two service factor conditions: nominal and degraded.

4. Response to simulated road roughness in a steady turn – to assess degradation in turning performance as the frequency of disturbance encounter is varied over a range including fundamental wheel hop frequency – two tire inflation pressures: nominal and overinflated.

5. Response to sinusoidal steer input – to quantify (1) degree of deviation from a trajectory whose final and initial paths are parallel, and (2) evidence of oscillatory or unstable behavior – as a function of maneuver severity over a range comparable to emergency lane changing – two service factor conditions: nominal and degraded.

6. Response to simultaneous half-sine steering input and pulse brake input – to quantify vehicle tendency to roll over as maneuver severity is varied over a range comparable to

emergency obstacle-avoidance situations – two service factor conditions: nominal and degraded.

The above recommendation does not imply that the scope of a second generation pilot program should be restricted exclusively to the procedures that have been developed. In certain respects, these procedures need refinement. For example, the development of a reliable procedure to measure vehicle sideslip angle under dynamic conditions would facilitate the interpretation of several of the tests. It must also be assumed that additional procedures, of at least equivalent safety relevance, could surely be developed. It appears that we have just begun to scratch the surface of a virtually limitless domain of investigations that are made possible with the aid of an automatic controller. Other combinations of steering and braking time histories could and should be programmed on the function generator and evaluated. By the same token, additional potentially relevant tests suitable for driver control should also be explored (e.g., response to aerodynamic inputs; response to roadholding during braking).

The performance measures defined in the study provide a meaningful focus for new analytical work and simulation activity. Mathematical models of the mechanics of the motor vehicle should be extended and refined to permit accurate simulation of these maneuvers. The existence of refined simulations would facilitate sensitivity analyses to guide the efforts of designers and researchers, and to provide new depths of understanding of the pre-crash dynamics of the roadway-vehicle system.

The Contract Technical Manager has certified that the contractor's work has been satisfactorily completed and that all contractual obligations have been met.

The opinions, findings, and conclusions expressed in this summary are those of the contractor and not necessarily those of the National Highway Traffic Safety Administration.

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executive summary

A SYNPOSIS OF A RECENTLY RELEASED NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION RESEARCH REPO

CHILD SEAT AND RESTRAINT SYSTEMS TEST PROGRAM

The objectives of this project were to define the state-of-the-art in child seating and restraint systems; to evaluate the various types of child seating and restraint devices in use; and, to recommend performance requirements and compliance test procedures for these devices and systems.

Contract FH-11-6962
Highway Safety Research Institute
The University of Michigan
Huron Parkway and Baxter Road
Ann Arbor, Michigan 48105
DOT/HS-800 376 Test Programs PB-197 555
DOT/HS-800 382 Child Seat and Restraint Systems Test Results Appendix D, Vol. I PB-197 552
DOT/HS-800 383 Child Seat and Restraint Systems Test Results Appendix D, Vol. II PB-197 553
DOT/HS-800 384 Child Seat and Restraint Systems Test Results Appendix D, Vol. III PB-197 554

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Contract Period: June 28, 1968 to July 1, 1971

Introduction to the Project

The project was begun by studying the current state-of-the-art and by conducting an extensive market survey of available seats and restraint systems. It was found that little is known about the impact tolerance of children and infants, but that numerous safety devices are being marketed by many manufacturers, both large and small. Specific attention was given to 125 devices being manufactured by 34 corporations. Of these, 37 devices manufactured by 26 of the companies were selected for the test program.

The first step in designing the test program, based on the completion of the market survey, was the selection of performance criteria to be used in evaluating the results. These criteria included the specification that body motions and decelerative g-loadings be limited and that forces applied directly to the body be well distributed.

Using the performance criteria as a guide, the test environment was selected which consisted of a durable bucket seat which could be mounted on the Highway Safety Research Institute's impact sled to simulate front, side, rear, and oblique impacts. The Sierra 3-year child dummy which served as the test subject for the bulk of the tests was instrumented with accelerometers to record head and chest g-loadings. High speed photographic coverage was also provided. A total of 120 dynamic sled tests were carried out.

Report Construction

A detailed discussion of the test program along with the description of the results are found in the main body of the report, parts III and IV. The raw test data are found in three separate volumes as Appendix D, and are summarized in a data table in the main text and in Appendix C which contains a discussion of each device tested.

Part V of the main body of the report consists of a discussion of performance requirements and com-

pliance test procedures. It is obvious that child restraint devices should limit the motions experienced by a child occupant. However, because of the lack of data on impact tolerance, only preliminary suggestions can be made for allowable loadings which can be safely experienced by the child. The authors of the report believe strongly that a dynamic test procedure using an impact sled or other dynamic device is necessary for a complete evaluation of performance and compliance to the recommendations set forth.

MAJOR CONCLUSIONS AND RECOMMENDATIONS

o Recommended Performance Requirements and Compliance Test Procedures

It has been suggested that three factors are extremely important in order to provide impact protection for the user of the restraint device. These are:

1. The extent of body motions experienced by the occupant;

2. Distribution of the load over the body of the occupant; and,

3. Tolerance of the occupant to impact loading.

o Recommendations for Performance Requirements

It is recommended that the motion experienced by the occupant be limited to a volume above the seat cushion of the adult seat. The limit to this volume is 24 inches wide and extends above the top of the adult seat back for 12 inches (sketch presented in the report). It extends from the front of the seat cushion to the top of the seat back. If motion is limited to this range, there is little danger of occupant contact with vehicle interior structures to the front, side, or rear.

The distribution of loads over the child's body surface which occurs as a result of interactions with the various types of restraint devices, is equally important. The growth patterns of children arysuch that their pelvic structure is not as effective in picking up belt loadings as it is for adults due to the immature structure of the iliac crests. In the case of many child seats and belt restraint systems which are currently marketed, belts which may act in the pelvic region have a nearly horizontal configuration as well as line of action for the application of forces. The proposed standard does not reflect the fact that a horizontal loading in the pelvic region or in the abdominal area could be extremely dangerous. Therefore, a performance requirement is recommended that the angle of action of any pelvic restraint be $45^{\circ} - 75^{\circ}$ from horizontal at the time of peak loading. Also, it is recommended that no restraint system elements apply loadings to the abdominal area between the pelvic structures and the bottom of the rib cage unless the primary load bearing elements distribute the bulk of the impact loads to these two regions.

In order to clearly define a requirement for the restraint of the torso, it is necessary to posess knowledge of its load carrying ability based on human tolerance data. Little data is available for adults (40 g limit to chest loads in forward impact) and there is none for children.

It is possible to suggest means by which performance requirements can be generated when sufficient data is available. For example, if it is assumed that: (1) a 40 g tolerance level for chest impact is applicable to children; and, (2) adequate restraint is provided by a properly positioned two-inch wide lap belt combined with two-inch straps over each shoulder; then it is possible to compute an average pressure level acting under the restraint system based on child body dimensions and weights.

Child Size Data (6-year male)
Torso Length – 13.0 inches
Torso Breadth – 7.1 inches
Body Weight – 48.2 pounds

For a six-year old child, the value is approximately 33 psi. This decreases to approximately 20 psi for an infant of six months. This type of an analysis can be applied to other restraint systems such as the airbag and contact panels (Ford Tot-Guard) where a contact area between user and restraint system can be estimated from high speed motion pictures in the case of a dynamic test procedure or a still photo in the case of a static test.

The major problems with this type of specification are a lack of tolerance data and a lack of instrumentation techniques for the measurement of contact pressures between surfaces. *First,* the 40 g chest tolerance level was determined for an adult and only represents forward impact. Before suitable tolerance data can be obtained for children, tolerance scaling techniques must be developed either from adult data to the child or from laboratory animal data to the child. *Second,* a pressure specification, such as the example given in the previous paragraph, defines a uniformly distributed loading. Even if the loading were uniform, which is unlikely, tolerance data for the impact pressure loadings which are likely to cause injury to each individual organ under the contact area of the restraint

system are unknown. *Third,* in order to validate the performance criterion the actual contact pressure levels should be measured. Dynamic pressure transducers are not yet available for this purpose. Before a pressure loading performance specification can be recommended with confidence, it is suggested that research be carried out in three areas: (1) tolerance data for children; (2) pressures applied to particular body areas causing injury; and, (3) development of dynamic contact pressure sensors.

To repeat, the tolerance to impact remains relatively unknown for children. On one hand, some medical experts believe that children are more compliant than adults and thus can safely resist higher loads. In this case, one might tend to feel safe in using an 80-g, 3 ms. limit to direct head impact, and a 20-g limit to vertical acceleration of the torso. In addition, one could estimate that this greater compliance could allow a greater degree of relative motion between adjacent body segments. On the other hand, this greater compliance is related to the fact that the bony, load-carrying structure of the body is not fully developed in children. The skull is soft and the bones are not yet fully connected to one another, making this area of the body extremely vulnerable. Also, the rib cage is readily compressed, leading to a potential for other internal injuries. Therefore, until such time as new data become available, accelerations applied to the head and chest should not exceed the values listed above in any dynamic test.

As a supplement to this recommendation, it is suggested that a restriction be placed on the relative motions which can occur between the major body elements such as head, torso, and lower extremities. The head should be limited to 45° rotation rearward or forward rotation relative to the torso and a similar value to the side. Also, a value of sideways rotation of the legs relative to the lower torso should be limited to 45° as long as the body does not extend outside the protective environment defined earlier. These values represent the voluntary rotation limits which can be accomplished without forcing joint structures beyond their normal range of flexibility. The possibility of injury exists if these limits are exceeded.

○ Observations on Restraint System Performance in a Dynamic Environment

Several additional observations can be made which would be helpful in the preparation of new or improved standards. These are based on observations of the dynamic tests and are concerned primarily with the performance of various design features found in devices which are currently marketed. Hence, these observations can not be directly included in performance requirements.

- Structural collapse should be avoided, but limited controlled deformation can be used effectively in restraint system design. The major problem is to avoid impingement of the child occupant on the collapsing structures.

- The method of attachment of the child restraint device to the adult seat has been found to be extremely important. The use of the adult seat belt proved to be the most effective means to tie-down observed during the course of the test program, but some other auxiliary straps which were supplied by the manufacturers of child seats also were effective. A number of tests which were carried out used bail hooks over the adult seat back, or a non-rigid restraint strap looped over the top of the adult seat back, under the seat back, and hooked to a common auxiliary bracket mounted on the floor of the vehicle. In several of these tests the fixed seat back (which meets Federal requirements on seat back strength) was broken and deformed forward as much as 24 inches. This led to a redesign of the HSRI sled fixture such that the seat back was braced to avoid this problem. It is thus observed that the seat back should not be used as an attachment point for bail hooks, auxiliary straps, or other devices unless it is especially strengthened to take a load of at least 1000 lbs applied at the top of the seat back, in front, side, and rear directions without permanent deformation.

- Dynamic interaction between the adult seat, child restraint device, and occupant has also been observed to be important and is one reason that a dynamic sled test is recommended on test procedures. The dynamics and inertial loads acting on the three parts of the system are difficult to duplicate in a static test. Also, the fact that the loads are being applied at a high rate effects the physical properties of many non-metallic materials such as the foams used in padding, cushions, and plastic shell structures. Also, possibly injurious rebound has been observed in some seats, sometimes caused by "springy" adult lap belts and other components which do not absorb energy. This property would not be observed in a static test. The coupling between the properties of the auto seat and child must also be considered. In the sled tests, distinct differences have been observed between hard and soft seat cushions.

- In fact, one manufacturer remarked that he could qualify his seat on a hard board but it would never qualify when tested on a soft seat structure.

- In some seats restrained by an adult lap belt, the occupant sits on a pedestal several inches above the seat cushion. It is possible for the child occupant to pitch forward with velocities amplified by the fact that the center of gravity of the child-seat system is so high. This dynamic response, dependent on inertial forces, would not be reflected in a static test. Finally, body segments such as the head are capable of providing rather complex inertial loadings on the other body segments and also on the seat and restraint system. It is thus recommended that the test procedure be a dynamic one and that a test occupant be segmented in at least three flexible parts (head, torso, lower extremities) in order to adequately simulate the performance of the child restraint system in a dynamic environment.

Test Procedures

In order to meet the performance requirements which have been discussed previously, a series of three impact sled tests is recommended. The four features of this test procedure are the occupant, the means of fastening the restraint device to an adult bucket seat, the acceleration profile which simulates the actual crash, and the test instrumentation.

- It is recommended that a flexible articulated dummy be used as the test device. For restraint devices intended for use by children weighing up to 30 lbs., a 3-year human simulator is recommended. For infants it will be necessary to develop a new test device similar to the doll which has been used in the present test program (3-month infant) or the doll used by General Motors Corp. in their development program. These test devices should be segmented in at least three parts (head, torso, and lower extremities) in order to simulate dynamic body motions, and should be capable of carrying accelerometers in both the head and torso.

- The child restraint device should be fastened to an adult seat representative of current design and manufacturing techniques and meeting Federal standards for seat back strength. A seat belt assembly should be provided to allow tie-down by this technique if its use is recommended by the manufacturer of the child restraint device. This belt should be mounted to the sled structure so that a 50th percentile male occupant in the seat would be restrained in the following manner. The angle of the belt should be 60° from the horizontal and now more than 10° out from a plane passing from the front to the rear of a hypothetical vehicle. If an adult seat belt is not to be used, any auxiliary straps should be fastened to the sled structure as recommended by the manufacturer in their instructions to the user.

- Three dynamic tests should be carried out on a device. The first is a "moderate" collision of 30 mph representing a frontal crash. The g-level should be approximately 20 g's, possess a sinusoidal shape, and have a duration of about 100 ms. This is a fairly good approximation of most barrier crashes at this speed. The other two tests should be 30-mph side and rear-end collisions. Although published experimental vehicle compartment data are limited on side and rear collisions, the deceleration levels are lower due to the crushability of the rear of most vehicles and the intrusion and whole-vehicle motion to the side in lateral collisions. A level of 12 g's is recommended for the side and rear test simulations.

- The instrumentation consists of photographic and transducer devices. Transducer devices should be chosen to determine sled g-pulse, impact velocity, acceleration loads applied to the occupant's head and chest, and belt loads on the adult belt system if it is used. High-speed motion picture cameras should be located where they can best record the motions experienced by the occupant. In most cases this will be to the side and above the impact site.

- A test procedure such as this can be carried out within one day on anyone of the several governmental, industry, and private research organization operated sleds which are located in this country. It is felt that a dynamic test requirement is required to determine child occupant restraint performance and that enough information is available to write a dynamic test standard.

The Contract Manager has certified that the contractor's work has been satisfactorily completed and that all contractual obligations have been met.

The opinions, findings, and conclusions expressed in this summary are those of the contractor and not necessarily those of NHTSA.

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